# Factors Affecting the Voluntary Intake of some Tasmanian Forages.

by

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SUMMARY

Measurements of voluntary intake, digestibility and chemical composition were made on a range of forage species and varieties in three series of indoor feeding trials. The aim was to determine the intake and digestibility levels of these forages, and the reasons for variations between forages in the voluntary intake - digestibility relations.

In the first trial, species were white clover, perennial ryegrass, short rotation ryegrass, Ariki ryegrass, currie cocksfoot and Apanui cocksfoot. These were harvested eight times between May 1969 and August 1970.

Digestibility and voluntary intake of white clover was higher than that of the grasses, digestibility of Apanui cocksfoot was lower than that of the other grasses. Within seasons, all species showed a similar intake - digestibility relation, however, at any digestibility level, voluntary intake of winter and autumn cut herbage was less than that of spring and summer cut herbage. Information from this trial did not exclude the possibility that the low winter intakes were due to environmental factors affecting animal appetite.

In the second trial, four species, short rotation ryegrass, Italian ryegrass, Tama ryegrass and oats were harvested three times between April and October 1973.

There were no differences between species or harvests in digestibility. However, voluntary intake in the spring harvest was

higher than in the autumn and winter harvests. A difference in intake between early and late cuts occurred in the autumn - winter harvest and as these cuts were fed in the same feeding trial, this indicated that the differences in intake were due to plant rather than animal factors.

In the third trial, perennial ryegrass and demeter fescue were harvested four times between October 1974 and October 1975, and lucerne was harvested seven times between January 1976 and March 1977.

Digestibilities of ryegrass and fescue were similar. No species differences in intake occurred but voluntary intake of winter harvests was lower than that of spring harvests.

Digestibility of lucerne was lower than normally found with the grass species and peaked at about 70 %. Voluntary intake tended to be high despite the moderate digestibility.

Within spring and summer cuts, voluntary intake of all species was closely related to digestibility but, at a given digestibility level, voluntary intake of lucerne but not clover was significantly higher than that of grass. This indicated that the higher intake of legume compared with grass mainly occurred with lower digestibility forages. Differences in intake between grass and legume could be explained by the lower level of neutral detergent fibre in legume.

In all trials, voluntary intake of winter and autumn cuts was lower than that of spring and summer cuts. These low intakes could not be explained on the basis of the chemical or in vitro measurements carried out. However, even within winter cuts, there was a positive relation between intake and digestibility and this indicated that the causal mechanism involved gastro-intestinal physical factors.

The best predictor of voluntary intake of combined season cuts was a multiple regression including digestibility and a measure of forage density. This indicated that a reduced density of packing of material in the rumen may have been the factor causing the reduced intakes on winter pasture.

INTRODUCTION

The efficiency with which animals convert the food they eat into animal products depends on many factors, including the structure of the animal population, whether dairy or beef cows, or whether ewes producing one or two lambs per year (Holmes and Jones 1964) and on the productive potential of the animals (Ivins et al 1958). However, a dominant factor is the level of nutrient intake of the animals being fed; the higher the nutrient intake, the higher the level of productivity of the animals, and the lower the nutrient requirement for each unit of animal output (Holmes and Jones 1964; Raymond 1969). Thus as the daily intake of a 300 kg steer increases from 64 to 85 MJ of metabolizable energy, its daily rate of liveweight gain increases from 0.5 to 1.25 kg per day; the corresponding requirement of metabolizable energy per kilogram gain decreases markedly from 128 to 68 MJ (Raymond 1969).

The level of nutrient intake by animals can be regarded as the product of three parameters (Raymond 1969):

Nutrient intake = intake of feed x digestibility of feed
x efficiency of utilisation of digested feed.

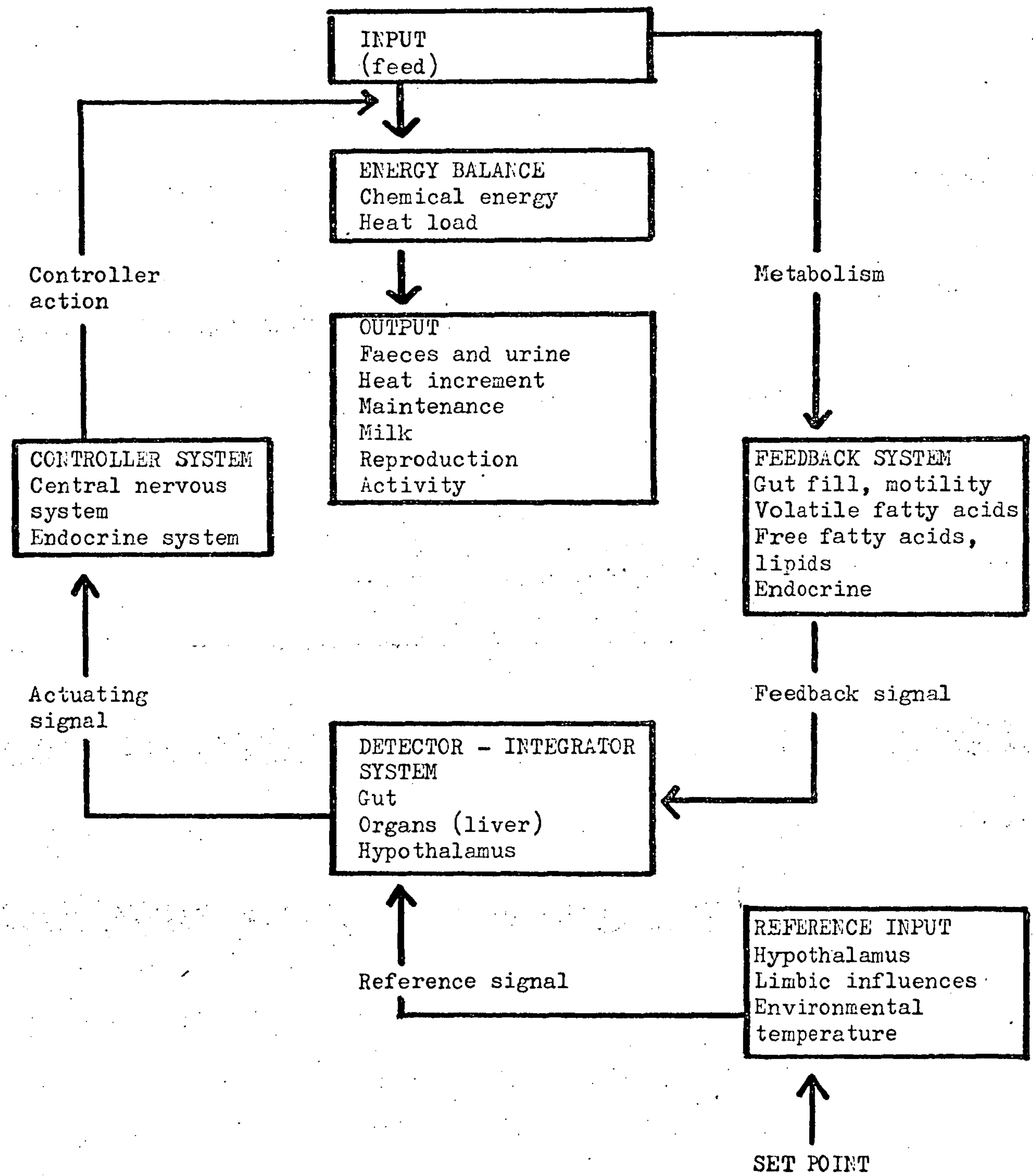
Under pen feeding and grazing situations, the dominant parameter and the major factor causing differences in productive potentials between forages is intake of feed. Crampton (1957) suggested that level of voluntary intake of a forage may be of pressing importance in describing its feeding value and Crampton, Donefer and LLoyd (1960) using multiple regression analysis found that voluntary intake was the major factor determining intake of digestible energy and liveweight gain of sheep pen fed a range of forages. This was confirmed by Ingalls et al (1965) who found that there was two and a half times as much variation in intake of a range of forages than in digestibility and that digestible energy intake, and thus liveweight gain was more closely related to intake than to digestibility of the forages. Corbett (1969) found that 60 to 75 % of differences in forages in intake of digestible dry matter was due to differences in intake. Voluntary intake therefore was a better measure of the value of forages than was digestibility.

Within feed classes, variation in the voluntary intake of food is usually a more important factor accounting for variation in animal production than is variation from food to food in the efficiency of utilisation of metabolizable energy (Blaxter 1964).

The ultimate limits to feed intake by ruminant animals are the homeostatic mechanisms that lead to long term energy balance (reviewed by Baumgardt 1970). Thus adult animals have the ability to maintain bodyweight at the same level, often for years, in spite of great variation in energy expenditure. On rations of adequate energy concentration, ruminants as well as non ruminants have the ability to control intake to maintain energy balance.

A tentative scheme for showing the feedback mechanisms controlling feed intake and energy balance has been reported by Baumgardt (1970) and this is shown in figure 1.

Figure 1. A tentative scheme for regulation of energy balance in ruminants (from Baumgardt 1970).



Final control of intake is probably exercised by the hypothalamus which integrates short term feedback signals from gut fill, metabolic product concentrations and endocrine state against an initial set point depending on long term energy demand.

In practical grazing situations however, the actual intake of feed by ruminants may be restricted to a level below that required for long term energy demand by the action of a number of factors.

A low feed intake for example, may be due to a low feed availability. The relation between feed intake and pasture allowance normally follows an asymptotic pattern and maximum intake is achieved when the pasture allowance is three to five times actual intake (i.e. a utilisation at a grazing of 20 to 30 %) (Reardon 1977; Gibb and Treacher 1978) or when the residue after grazing is at least 1500 to 2000 kg of dry matter per hectare (Arnold and Dudzinski 1966; Taylor 1966; Hodgson Taylor and Lonsdale 1971). The reduced intake with lower feed allowances is probably largely due to difficulty by animals in harvesting sufficient feed to satisfy their requirements in the time available but it is possibly partly due to a reduced digestibility of the feed residues (Fontenot and Blaser 1965; Hodgson, Taylor and Lonsdale 1971; Nicol et al 1976).

Under a grazing situation where feed availability is not limiting however, level of animal production will depend on the intrinsic factors which determine voluntary intake of that forage. Voluntary intake can be defined as the amount of feed eaten by an animal when food is offered ad libitum (Campling 1964).

The term palatability has often been equated with voluntary intake (Ivins, Dilnot and Davison 1958; Garner 1963). Factors that may affect palatability of a feed such as smell, taste and texture affect animals in a subjective fashion and are difficult to quantify objectively (Campling 1964). Palatability can be measured by allowing animals free access to a range of feeds and in some cases palatability measured in this way correlates with voluntary intake. For example, palatability of reed canary grass (Phalaris arundinacea) strains is related to their alkaloid contents and the differences in palatability apparently involve the senses of taste and smell (Simons and Marten 1971). These palatability differences have been shown to be associated with differences in animal intake (O'Donovan et al 1967).

However with normal forages, although animals may show distinct preferences for certain forages in free access trials, these preference ratings normally do not correlate with voluntary intake when the feeds are offered singly (Reid Jung and Murray 1966; Reid and Jung 1965). Weston (1966) concluded after feeding part of the diet through a rumen fistula, that palatability was not a factor causing differences in intake between lucerne and wheaten hay, however, Greenhalgh and Reid (1967) using a similar technique found evidence suggesting that a difference in palatability was an important factor in determining differences in intake of straw and dried grass.

Although it is generally accepted that palatability factors are important in determining grazing selection and relative intakes of different forages in situations of free choice (Arnold 1966), there is considerable evidence to show that with diets consisting mainly of roughages, the main factor limiting voluntary intake is the capacity of the reticulo-rumen and the rate of disappearance of digesta from this organ (Campling 1969). In consequence, with these diets there is often a direct relation between voluntary intake and digestibility (Balch and Campling 1962; Corbett 1969; Raymond 1969).

Ruminants are able to eat much more of highly digestible forages than of less digestible forages because the latter occupy more volume and are within the rumen for a longer time and because from them, more indigestible material has to be passed down the hind tract (Balch and Campling 1962). A decrease in voluntary intake as forages become more mature and so less digestible has been shown in many experiments (Crampton, Donefer and Lloyd 1960; Minson et al 1964; Heaney, Pigden and Pritchard 1965; Osbourne, Thomson and Terry 1966).

Such evidence led to the concept that the voluntary intake of a forage could be predicted from its digestibility, however, there is now increasing evidence that this is too simplified a concept (Raymond 1969). It was soon found that different forages at the same digestibility may be eaten in different amounts. For example, intake of legume was found to be higher than that of grass at the same digestibility (Reid and Jung 1965; Demarquilly 1966; Van Soest 1965; Milford and Minson 1966; Osbourne, Thomson and Terry 1966; Milford 1967; Weston and Hogan 1967; Troelsen and Campbell 1969). Low intakes have been reported with some grass species, for example timothy (Phleum pratense) (Minson et al 1964; Miles, Walters and Evans 1969; Walters 1971), tall fescue (Festuca arundinacea) (Reid and Jung 1965) and some varieties of Panicum (Minson 1971).

If forage intake is determined by rumen fill and rate of disappearance of digesta from the reticulo-rumen, then rate of digestion of a forage should be a better predictor of voluntary intake than extent of digestion which is the factor measured in digestibility trials.

Forage components are broken down at different rates. Cell contents such as soluble carbohydrates, organic acids, lipids and most proteins are quickly and completely digested as the forage passes through the ruminant digestive tract while the breakdown of the cell wall polysaccharides and lignin is slower and less complete (Jarridge, Demarquilly and Dulphy 1974; Van Soest 1967).

Osbourne, Thomson and Terry (1966) found marked differences in voluntary intake in the order lucerne > ryegrass > timothy at the same digestibility. Chemical analysis of these forages showed that the digestible fraction in lucerne had a higher proportion of pepsin soluble material and a lower proportion of digestible fibre than the digestible fraction of timothy and the levels with ryegrass were intermediate. Van Soest (1965) similarly reported that lucerne contained a higher proportion of cell contents and a lower proportion of cell wall constituents than grass of the same level of digestibility. Thus at the same digestibility level, lucerne would contain a higher proportion of rapidly digestible material than grass and ryegrass a higher proportion than timothy. These feeds should therefore be subjected to a faster rate of digestion, and animals as a result would be able to eat more. The faster rate of digestion of lucerne has been confirmed (Chenost et al 1970).

Diploid grasses were found to have a higher intake level than tetraploid grasses of the same species (Osbourne, Thomson and Terry 1966) and Osbourne (1967) found that this was also associated with a higher content of pepsin soluble material. Minson (1971) found large differences in intake of tropical grass varieties at a similar digestibility and Thornton and Minson (1972) found that there was little difference between varieties in rumen fill and that the major factor causing the differences in intake was the retention time in the rumen and this in turn was related to the fibre components and the proportion of relatively indigestible constituents in the diet.

A number of reports have shown that rate of digestion, as measured by disappearance of material in a short term in vitro digestibility trial, was a better predictor of voluntary intake than was digestibility (Donefer, Crampton and Lloyd 1960; Johnson et al 1962), especially intake of mixed grasses and legumes. However, Laredo and Minson (1973) found that rate of digestion in vitro did not explain differences in voluntary intake of stem and leaf fractions of tropical grasses.

Pelleted rations have different rumen fill and rate of passage characteristics to their natural form counterparts (Montgomery and Baumgardt 1965) and these authors introduced the concept of feed density on the assumption that, at a given level of digestibility, a feed with a higher density (e.g. ground and pelleted versus long hay, grain versus roughage) will have:

a) a more rapid rate of digestion;

b) a more rapid rate of passage, and

c) will occupy less space in the digestive tract per unit weight.

Preliminary observations indicated that digestible dry matter x density was a better predictor of intake of both long forage and pelleted rations than digestible dry matter alone. Thornton and Minson (1973) found that part of the difference in intake between grasses and legumes could be attributed to a difference in packing density of feed in the rumen. However, Laredo and Minson (1973) found that density differences did not explain differences in intake of leaf versus stem of tropical grasses, stem had a lower intake despite a higher density.

With high digestibility diets it has often been found that the relation between voluntary intake and digestibility is less distinct. Hutton (1963) found that intake did not increase with increasing digestibility above about 70 % digestibility and Conrad, Pratt and Hibbs (1964) and Baumgardt (1967) found no increase in intake of roughage - concentrate diets when digestibility increased above about 65 %. In contrast, Osbourne, Thomson and Terry (1966) and Hodgson, Rodriguez Capriles and Fenlon (1977) found a linear relation between voluntary intake and digestibility up to digestibilities of 80 %.

It appears with these high digestibility feeds that energy concentration is sufficiently high for intake to begin to be influenced by long term homeostatic mechanisms rather than by gastro-intestinal fill. With these diets, rumen fill is smaller than is found with poorer quality roughages (Conrad, Pratt and Hibbs 1964; Montgomery and Baumgardt 1965; Campling 1969).

Although there are simple laboratory procedures that can accurately predict the digestibility of forages (Tilley and Terry 1963), it appears there is no single explanation why different forages may have different voluntary intake levels at a given digestibility and as a result, there is no satisfactory laboratory test available that can reliably predict voluntary intake. Therefore, in order to be able to predict the voluntary intake of a forage and thus the value of that forage in terms of the level of animal production it could support, it is necessary to have information on both the digestibility of the forage and on the forage's specific relation between digestibility and voluntary intake.

Voluntary intake may be measured under grazing situations however, techniques involve either measurements of pasture disappearance at a grazing which involves problems of measuring pasture yield and problems of loss of pasture due to treading and decay during grazing; or measurements of faecal output, directly or indirectly, in association with estimates of digestibility of the actual diet eaten. These techniques are laborious and are subject to errors and biases (Minson 1963; Raymond 1969). As well, due to selective grazing, animals may be eating a diet different from the average on offer (Arnold 1962) and this will cause problems in estimating diet digestibility and in interpreting the results. As well, intake level may be affected by extrinsic factors such as feed availability.

The standard method of measuring voluntary intake of forages therefore is by using indoor feeding trials (Minson 1968). Intake measured in this fashion gives an accurate and repeatable measure of voluntary intake as defined by Campling (1964).

Forages may be cut and fed daily or may be cut in bulk and preserved by freezing or drying and this processing causes little change in digestibility or voluntary intake (Minson 1966; Demarquilly and Jarridge 1970).

There is some argument on the degree of selection that should be allowed in an indoor feeding trial (Minson 1968). If animals are to achieve an ad libitum intake then some excess feed must be provided however, if the excess is too large then animals will be able to select a higher quality fraction from within the feed allowance (Raymond Harris and Kemp 1955) and as well, the sample taken for chemical analysis will have different characteristics from the forage actually eaten. Crampton, Donefer and Lloyd (1960), Blaxter, Wainman and Wilson (1961) and Wilson and McCarrick (1967) fed an excess of 5 to 15 % of feed and removed residues daily. Minson (1968) used a technique where a minimum level of feed was always available but feed residues were only collected at the end of the trial. In this case the rejection rate was about 5 %.

Significant between animal variation occurs in voluntary intake of the order of 13 % (Crampton, Donefer and Lloyd 1960) and in order to pick up differences in intake of about 10 % ($P = 0.05$), then a minimum of ten animals per feed is required.

Measurement of forage digestibility involves a preliminary feeding period during which the animals adapt to the feed under test and a measurement period in which feed eaten and faecal output are measured.

Not all the faecal output is made up of undigested feed residues, some consists of animal metabolic products. As a result, this method measures "apparent" as distinct from "true" digestibility. There is a level of feeding effect on digestibility (Raymond, Minson and Harris 1959), at high levels of intake, rate of passage of feed is increased and digestibility falls. The extent of the fall is higher with low digestibility forages, thus with feeds of digestibility about 70 %, the fall in digestibility with a unit increase in intake (i.e. from maintenance to twice maintenance) is about three digestibility units (ARC 1965), and with feeds of about 50 % digestibility, the fall is about twice this.

Variation in the digestive efficiency between animals is normally found to be of the order of 2 %, thus three animals per feed are sufficient to pick up digestibility differences of about five units ($P = 0.05$) (Corbett 1969).

Over the period 1969 to 1976 I carried out a series of trials to measure the digestibility, voluntary intake and digestibility - voluntary intake relations of a number of forages commonly used in Tasmania. A series of chemical analyses were carried out on the forage samples with the aim of helping to explain differences in digestibility and voluntary intake that occurred.

## METHODS

### Forage species

Single species swards were established on an area at the Cressy Research Station in Tasmania (Latitude 41° 43'S, elevation 150 m, average annual rainfall 691 mm, soil type Panshanger sand (Nicolls 1957). The area was divided into two blocks, each of about 2 ha, and one plot of each species was established in each block.

All plots received annual dressings of 250 kg $ha^{-1}$ each of superphosphate and potassium chloride, and grass plots received 125 kg $ha^{-1}$ of urea after each harvest. Herbicides were used occasionally during the establishment phase to obtain pure swards and when herbicides were used the next harvest was not used in a feeding trial. Spray irrigation was used to aid in establishment of the swards and occasional summer irrigations (about 50 mm) were used to ensure that pastures continued to grow over the summer.

### Trial 1

Six species were sown in December 1968, the species were:
Trifolium repens (white clover cv. Grasslands Huia),
Lolium perenne (perennial ryegrass cv. Tasmania No. 1),
Lolium perenne (long rotation ryegrass cv. Grasslands Ariki),
Lolium perenne x L. multiflorum (short rotation ryegrass cv. Grasslands Manawa),
Dactylis glomerata (cocksfoot cv. Currie) and
Dactylis glomerata (cocksfoot cv. Grasslands Apanui).

These plots were harvested for measurement in May, August (grasses only), September - October and November 1969, and January, March, May and August (grasses only) 1970.

Trial 2

Four species:

Lolium perenne x L. multiflorum (short rotation ryegrass cv. Grasslands Manawa),

Lolium multiflorum (Italian ryegrass cv. Grasslands Paroa),

Lolium multiflorum (Italian ryegrass cv. Grasslands Tama) and

Avena sativa (oats cv. Blythe)

were sown in January 1973 and harvests for measurement were taken in April - May, July and October 1973.

Trial 3

Three species:

Lolium perenne (perennial ryegrass cv. Tasmania No. 1),

Festuca arundinacea (tall fescue cv. Demeter) and

Phalaris tuberosa (phalaris cv. Australian)

were sown in February 1974. The phalaris plots did not establish satisfactorily and were abandoned.

Harvests of perennial ryegrass and demeter fescue were taken in October 1974, May, August - September and October 1975.

Plots of:

Medicago sativa (lucerne cv. Hunter River)

were sown in October 1974 and these were harvested in January, February, April, October and December 1975 and February and March 1976. At the February 1975, October 1975 and February 1976 harvests, a proportion of each plot was allowed to grow on and was harvested as a long regrowth treatment at the next harvest. This harvesting arrangement is shown in results tables (e.g. table 22).

Harvesting

Harvesting commenced when the grasses were 15 to 20 cm high. only one cut was taken on any one day but the harvest of all plots was completed as quickly as possible. Whenever possible, each plot was harvested and treated separately, but if insufficient material was available, both plots of one species were combined into a single cut. Apart from the cases where both plots of a species were combined, harvesting of the first block of species was completed before harvesting of the second commenced. At the completion of each harvest, the whole area was again cut to remove unequal growth.

Herbage was cut with a single cut flail action forage harvester, and was blown directly into a trailer for transport to Launceston for drying. The material was dried in a batch drier using hot air with an inlet temperature of 50°C. The herbage reached a uniform level of 87 to 92 % dry matter after about 20 hours.

Grasses and lucerne were chopped to a length of 2 to 4 cm and were blown directly into wheat sacks. Clover was bagged without prior chopping. The material in each sack was sampled and the bulked sample from each cut was sub sampled for dry matter determination and chemical analysis. The sacks of herbage were stored until the harvest was complete and the feeding trial commenced within several weeks.

Feeding trials

Corriedale wethers aged between two and five years were used in all feeding trials. Between trials they were permitted to graze or were fed hay in such a way as to be kept in good but not fat body condition. As far as possible, each cut was fed to five sheep over a period of four weeks, thus providing results for ten sheep for each forage species at each harvest. When a cut was a combination of both plots, this material was fed to six sheep. In some cases however, a shortage of material necessitated a lesser number of sheep.

The sheep were regrouped at the start of each trial on the basis of an equal body weight distribution between groups, and were randomly distributed throughout the shed in individual pens. Body weights were measured at the start and finish of each trial after 24 hours food removal. The sheep were dosed with thiabendazole at the start of each trial to control helminth infestations.

Each sheep was fed morning and evening, feed tins were emptied and the feed refusals from each sheep were collected weekly. The first week was regarded as a preliminary period and results were not included in the final calculations.

Faeces were collected over seven day periods in the second, third or fourth week using faecal collection harness. Faecal production levels were determined using two or three sheep on each cut and these together with the appropriate intake figures were used to calculate apparent digestibility. Faeces were collected night and morning and a 10 % sample from each collection was stored at - 5°C. At the end of each trial the bulked faeces sample from each sheep was dried at 105°C and weighed.

Chemical analyses

Herbage samples were milled to pass a 1 mm screen and were analysed for:

dry matter by oven drying at 105°C,

crude protein by micro Kjeldahl analyses,

water soluble carbohydrates (Deriaz 1961),

neutral detergent fibre (Van Soest and Wine 1967),

acid detergent fibre (Van Soest 1963) and

12 hour in vitro digestibility (samples from trial 1 only) using the method of Alexander and McGowan (1966) but with a 12 hour rumen liquor fermentation and with no pepsin stage.

Calculations.

Analyses of the differences between species in digestibility and voluntary intake, within harvests, were carried out using the mean results of individual sheep. Analyses of overall species and harvest effects were carried out using the mean result of each species at each harvest. In deriving relationships between digestibility, intake and chemical composition, results of the individual cuts, as shown in the appendix, were used.

Species and date effects were evaluated by analysis of variance and t test. Linear and multiple regression analyses and testing for differences between regressions were carried out using the methods described by Williams (1959).

## RESULTS TRIAL 1

The pasture swards remained relatively pure throughout the trial. Some clover was present in the grass plots in the spring and early summer, but the level did not rise above 5 % of dry matter. In all other cases, impurities were less than 1 % of dry matter.

### Digestibility and voluntary intake

Table 1 shows the mean dry matter digestibilities and average days regrowth of the six species for the eight harvests. Table 2 shows the mean dry matter intakes. Because there were no clover cuts in August of either year, two sets of comparisons are made in these tables. Firstly, the species and harvest means are derived for all species at the six harvests where clover was represented and secondly, the same means are derived for the grass species at all harvests.

Table 1 Dry matter digestibilities of the six species at each harvest.

Dry matter digestibility (%) and (average days regrowth)

| Harvest date | WC | MR | AR | PR | CC | AC | Mean All species | Mean Grasses |
|---|---|---|---|---|---|---|---|---|
| May 1969 | $76.6^{a}$ (36) | $72.3^{b}$ (38) | $71.6^{ab}$ (39) | $70.3^{c}$ (40) | $70.6^{bc}$ (40) | $61.5^{d}$ (41) | $70.5^{bc}$ (39) | $69.3^{cd}$ (39) |
| Aug. '69 | — | $76.2^{a}$ (81) | $69.6^{c}$ (83) | $73.7^{ab}$ (89) | $72.6^{bc}$ (89) | $69.8^{c}$ (84) | — | $72.4^{ab}$ (85) |
| Sep. - Oct. '69 | $81.4^{a}$ (49) | $74.4^{bc}$ (28) | $74.0^{bc}$ (41) | $76.9^{b}$ (42) | $75.2^{b}$ (42) | $71.2^{c}$ (40) | $75.5^{a}$ (40) | $74.3^{a}$ (39) |
| Nov. '69 | $79.0^{a}$ (35) | $70.2^{b}$ (28) | $67.7^{bc}$ (34) | $67.6^{bc}$ (32) | $64.7^{c}$ (31) | $67.1^{c}$ (35) | $69.4^{c}$ (32) | $67.5^{d}$ (32) |
| Jan. '70 | $73.2^{a}$ (58) | $69.2^{a}$ (55) | $72.9^{a}$ (55) | $70.8^{a}$ (52) | $68.7^{a}$ (53) | $62.5^{b}$ (49) | $69.6^{bc}$ (54) | $68.8^{cd}$ (53) |
| Mar. '70 | $73.8^{a}$ (37) | $71.9^{a}$ (44) | $71.2^{a}$ (38) | $67.2^{b}$ (34) | $70.2^{ab}$ (43) | $70.1^{ab}$ (35) | $70.7^{bc}$ (38) | $70.1^{bcd}$ (39) |
| May 1970 | $80.3^{a}$ (52) | $73.3^{b}$ (50) | $71.6^{b}$ (46) | $70.4^{b}$ (47) | $71.3^{b}$ (46) | $66.7^{c}$ (43) | $72.3^{b}$ (47) | $70.7^{bc}$ (46) |
| Aug. '70 | — | $70.9^{a}$ (95) | $69.0^{a}$ (98) | $68.8^{a}$ (98) | $63.3^{a}$ (99) | $68.1^{a}$ (91) | — | $68.0^{cd}$ (97) |
| Mean All species | $77.4^{a}$ (45) | $71.9^{b}$ (42) | $71.5^{b}$ (42) | $70.5^{b}$ (41) | $70.1^{b}$ (43) | $66.5^{c}$ (40) | | |
| Mean Grasses | — | $72.3^{a}$ (54) | $71.0^{ab}$ (55) | $70.7^{ab}$ (56) | $69.6^{b}$ (58) | $67.1^{c}$ (50) | | |

abcd Values within rows or means followed by the same letter do not differ ($P < 0.05$).

WC = white clover

MR = Manawa ryegrass

AR = Ariki ryegrass

PR = perennial ryegrass

CC = Currie cocksfoot

AC = Apanui cocksfoot

Mean digestibility of white clover was higher overall ($P < 0.05$) than that of the grasses and digestibility of Apanui but not Currie cocksfoot was lower than that of the ryegrasses ($P < 0.05$), there were no significant differences between the ryegrasses. Within harvests, some differences between species occurred. White clover had a higher digestibility than the grasses in the May 1969, November 1969 and May 1970 harvests ($P < 0.05$). Apanui cocksfoot had a lower digestibility than the other grasses in the May 1969, January 1970 and May 1970 harvests ($P < 0.05$).

Figure 2 shows the dry matter digestibility of white clover and of the mean of the grasses over the eight harvests. Under the regrowth type management used in this trial, the seasonal pattern of digestibility change in the grasses showed a relatively stable level over the summer, autumn and winter, a rise in the early spring as the period of rapid growth commenced and a fall in late spring after ear emergence. The digestibility of white clover remained high over the winter and early spring and declined slowly over the late spring and summer.

Figure 2. Seasonal pattern of change of voluntary intake and digestibility.

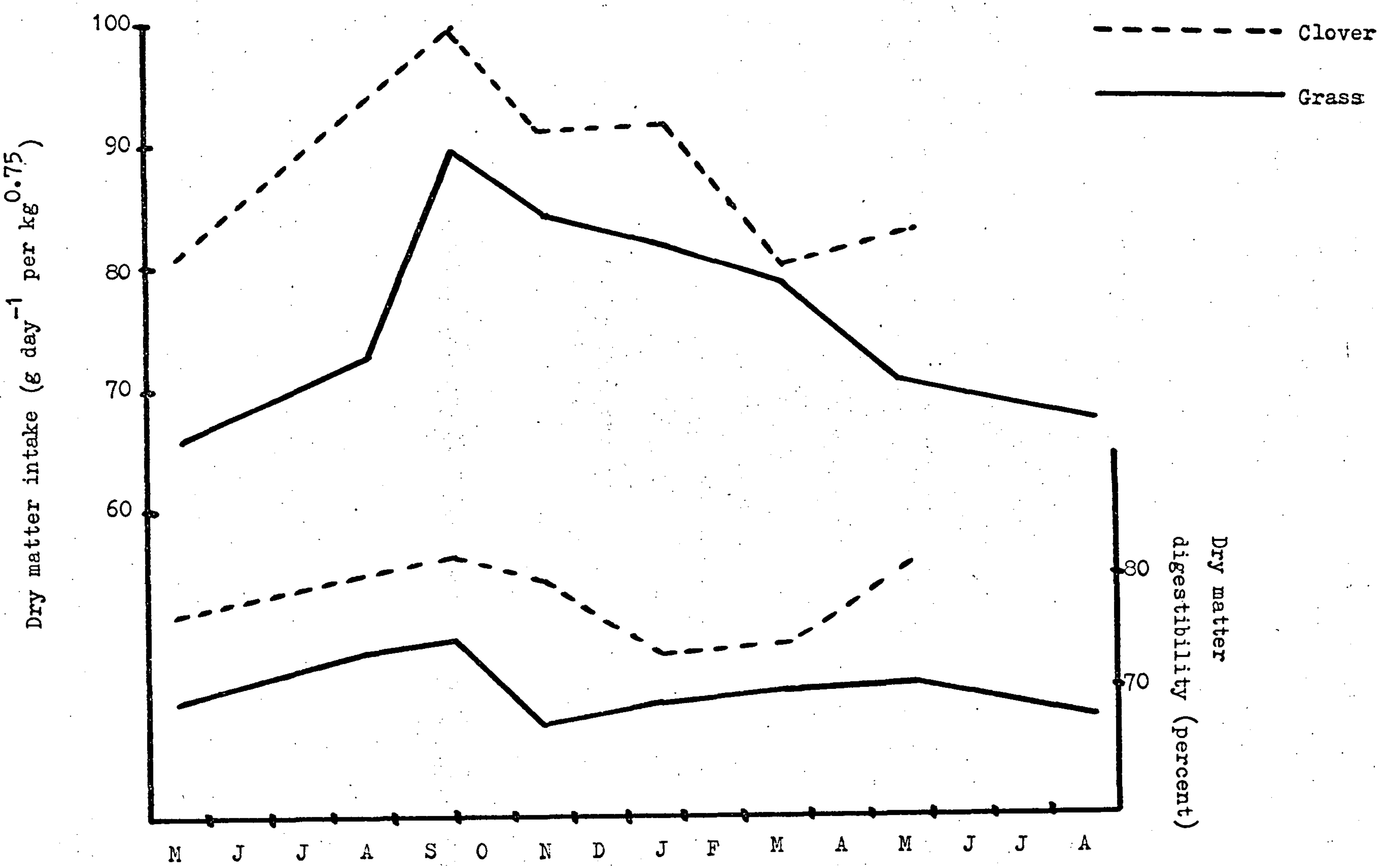


Table 2 : Dry matter intakes of the six species at each harvest.

Dry matter intake (g day$^{-1}$ per kg$^{0.75}$)

| Harvest date | WC | MR | AR | PR | CC | AC | Mean All species | Mean Grasses |
|---|---|---|---|---|---|---|---|---|
| May 1969 | 81.0$^{a}$ | 71.6$^{ab}$ | 65.7$^{bc}$ | 65.6$^{bc}$ | 65.0$^{bc}$ | 61.4$^{c}$ | 68.4$^{d}$ | 65.9$^{f}$ |
| Aug. '69 | — | 74.9$^{a}$ | 70.0$^{a}$ | 74.8$^{a}$ | 73.4$^{a}$ | 70.0$^{a}$ | — | 72.7$^{d}$ |
| Sep.- Oct. '69 | 100.0$^{a}$ | 84.3$^{b}$ | 87.8$^{b}$ | 92.1$^{ab}$ | 96.4$^{ab}$ | 89.2$^{ab}$ | 91.6$^{a}$ | 90.0$^{a}$ |
| Nov. '69 | 91.5$^{a}$ | 87.3$^{ab}$ | 84.0$^{abc}$ | 84.7$^{abc}$ | 78.8$^{c}$ | 83.3$^{bc}$ | 84.9$^{b}$ | 83.6$^{b}$ |
| Jan. '70 | 91.9$^{a}$ | 80.2$^{c}$ | 86.4$^{b}$ | 89.5$^{ab}$ | 79.5$^{cd}$ | 74.9$^{d}$ | 83.8$^{b}$ | 82.1$^{bc}$ |
| Mar. '70 | 79.7$^{a}$ | 78.0$^{a}$ | 76.8$^{a}$ | 80.0$^{a}$ | 80.9$^{a}$ | 77.1$^{a}$ | 78.8$^{c}$ | 78.6$^{c}$ |
| May 1970 | 83.0$^{a}$ | 74.2$^{ab}$ | 67.8$^{bc}$ | 66.5$^{c}$ | 74.1$^{ab}$ | 69.4$^{bc}$ | 72.5$^{d}$ | 70.4$^{de}$ |
| Aug. '70 | — | 67.5$^{a}$ | 67.5$^{a}$ | 68.5$^{a}$ | 65.6$^{a}$ | 68.0$^{a}$ | — | 67.4$^{ef}$ |
| Mean All species | 87.9$^{a}$ | 79.3$^{b}$ | 78.2$^{b}$ | 79.6$^{b}$ | 79.1$^{b}$ | 75.9$^{b}$ | | |
| Mean Grasses | — | 77.3$^{a}$ | 75.8$^{a}$ | 77.6$^{a}$ | 76.7$^{a}$ | 74.2$^{a}$ | | |

Mean voluntary intake of white clover was higher overall than that of the grasses ($P < 0.05$) and there were no significant differences between the grasses. Within harvests, some minor differences did occur and these generally followed differences in digestibility.

Figure 2 shows the intake of white clover and of the mean of the grasses over the eight harvests. Intake of all the species was low in the winter, rose rapidly to a peak in early spring, fell in mid spring to a stable level over the summer and fell further in the autumn back to the low levels of winter pasture. As shown in table 2, the intake of spring pasture was higher ($P < 0.05$) and intake of winter pasture was lower ($P < 0.05$) than that of pasture cut at other times.

Chemical composition

Tables 3, 4, 5, 6 and 7 show crude protein, water soluble carbohydrate, neutral detergent fibre and acid detergent fibre levels and 12 hour in vitro digestibility of the six species at each harvest. As in tables 1 and 2, the species and harvest means are derived for all the species at the six harvests when clover was represented and the same means are derived for the grass species at all eight harvests.

Table 3 Crude protein contents of the six species at each harvest.

Crude protein (% of dry matter)

| Harvest date | WC | MR | AR | PR | CC | AC | Mean All species | Mean Grasses |
|---|---|---|---|---|---|---|---|---|
| May 1969 | 24.8 | 16.2 | 18.4 | 17.7 | 21.2 | 21.5 | 20.0[b] | 19.0[b] |
| Aug. '69 | -- | 16.4 | 14.4 | 14.6 | 17.1 | 17.2 | -- | 15.9[c] |
| Sep. - Oct. '69 | 21.6 | 21.6 | 17.4 | 17.9 | 21.2 | 23.4 | 20.5[b] | 20.3[b] |
| Nov. '69 | 33.5 | 14.4 | 13.4 | 14.1 | 14.8 | 17.4 | 17.9[b] | 14.8[c] |
| Jan. '70 | 17.3 | 9.6 | 10.8 | 12.4 | 13.4 | 12.7 | 12.7[c] | 11.8[d] |
| Mar. '70 | 35.9 | 22.3 | 21.2 | 23.3 | 25.5 | 26.1 | 25.7[a] | 23.7[a] |
| May 1970 | 26.0 | 17.8 | 16.7 | 17.1 | 20.2 | 17.5 | 19.2[b] | 17.9[b] |
| Aug. '70 | -- | 15.7 | 19.0 | 19.0 | 22.3 | 19.7 | -- | 19.1[b] |
| Mean All species | 26.5[a] | 17.0[b] | 16.3[b] | 17.1[b] | 19.4[b] | 19.8[b] | | |
| Mean Grasses | -- | 16.8[b] | 16.4[b] | 17.0[b] | 19.5[a] | 19.4[a] | | |

White clover had a significantly higher crude protein content than the grasses ($P < 0.05$) and cocksfoot had higher levels than the ryegrasses ($P < 0.05$). Protein contents of all the species were highest in autumn and lowest in late summer.

Table 4 Water soluble carbohydrate contents of the six species at each harvest.

Water soluble carbohydrates (% of dry matter)

| Harvest date | WC | MR | AR | PR | CC | AC | Mean All species | Mean Grasses |
|---|---|---|---|---|---|---|---|---|
| May 1969 | 9.0 | 14.5 | 11.0 | 14.5 | 7.5 | 7.5 | 10.7 [b] | 11.0 [b] |
| Aug. '69 | -- | 15.3 | 10.9 | 15.5 | 10.2 | 9.1 | -- | 12.2 [b] |
| Sep. - Oct. '69 | 10.3 | 16.8 | 24.5 | 26.9 | 16.8 | 13.2 | 18.4 [a] | 20.0 [a] |
| Nov. '69 | 10.2 | 26.9 | 23.3 | 21.7 | 12.6 | 12.1 | 17.8 [a] | 19.3 [a] |
| Jan. '70 | 8.5 | 16.3 | 12.3 | 13.5 | 5.6 | 4.4 | 10.1 [b] | 10.4 [b] |
| Mar. '70 | 4.8 | 13.5 | 15.1 | 12.1 | 5.9 | 3.8 | 9.2 [b] | 10.1 [b] |
| May 1970 | 7.8 | 16.8 | 13.5 | 11.7 | 7.8 | 8.1 | 11.0 [b] | 11.6 [b] |
| Aug. '70 | -- | 17.6 | 12.5 | 15.0 | 7.8 | 11.4 | -- | 12.9 [b] |
| Mean All species | 8.4 [b] | 17.5 [a] | 16.6 [a] | 16.7 [a] | 9.4 [b] | 8.5 [b] | | |
| Mean Grasses | -- | 17.2 [a] | 15.4 [a] | 16.4 [a] | 9.3 [b] | 9.0 [b] | | |

Ryegrasses had higher water soluble carbohydrate contents than white clover and the cocksfoots ($P < 0.05$) and with all species, levels were highest in spring and early summer ($P < 0.05$).

Table 5. Neutral detergent fibre contents of the six species at each harvest.

Neutral detergent fibre (% of dry matter)

| Harvest date | WC | MR | AR | PR | CC | AC | Mean All species | Mean Grasses |
|---|---|---|---|---|---|---|---|---|
| May 1969 | 28.9 | 44.2 | 43.9 | 44.9 | 45.1 | 52.0 | 43.2[a] | 46.0[a] |
| Aug. '69 | -- | 43.5 | 48.2 | 43.1 | 46.4 | 46.7 | -- | 45.6[a] |
| Sep. - Oct. '69 | 27.0 | 44.3 | 45.7 | 45.1 | 48.6 | 51.0 | 43.6[a] | 46.9[a] |
| Nov. '69 | 35.1 | 52.7 | 57.7 | 57.0 | 70.3 | 60.5 | 55.6[bc] | 59.6[bc] |
| Jan. '70 | 39.1 | 62.1 | 61.0 | 60.0 | 67.6 | 66.6 | 59.4[c] | 63.5[c] |
| Mar. '70 | 46.0 | 51.6 | 53.0 | 54.5 | 62.3 | 59.3 | 54.5[b] | 56.1[b] |
| May 1970 | 30.4 | 51.3 | 55.0 | 57.1 | 59.0 | 59.6 | 52.1[b] | 56.4[b] |
| Aug. '70 | -- | 49.1 | 55.3 | 52.9 | 59.9 | 54.5 | -- | 53.9[b] |
| | 34.4[a] | 51.0[b] | 52.7[b] | 53.1[b] | 58.8[c] | 58.2[c] | Mean All species | |
| | -- | 49.9[a] | 52.2[a] | 51.8[a] | 57.4[b] | 56.3[b] | Grasses | |

Neutral detergent fibre content of white clover was much lower than that of the grasses ($P < 0.05$) and ryegrass had a lower level than cocksfoot ($P < 0.05$). Levels did not appear to follow a distinct seasonal pattern, lowest neutral detergent fibre contents were found in the first winter and spring and highest levels were found in the summer ($P < 0.05$).

Table 6 Acid detergent fibre contents of the six species at each harvest.

Acid detergent fibre (% of dry matter)

| Harvest date | WC | MR | AR | PR | CC | AC | Mean All species | Mean Grasses |
|---|---|---|---|---|---|---|---|---|
| May 1969 | 18.6 | 21.5 | 23.3 | 25.0 | 24.5 | 28.5 | 23.6[a] | 24.6[b] |
| Aug. '69 | -- | 22.3 | 25.4 | 22.0 | 25.7 | 26.9 | -- | 24.5[b] |
| Sep. - Oct. '69 | 19.7 | 22.4 | 22.0 | 20.4 | 20.4 | 23.0 | 21.3[a] | 21.6[a] |
| Nov. '69 | 23.2 | 24.9 | 28.8 | 29.5 | 36.6 | 31.5 | 29.1[b] | 30.3[d] |
| Jan. '70 | 30.3 | 33.4 | 29.0 | 28.0 | 36.7 | 35.6 | 32.2[c] | 32.5[d] |
| Mar. '70 | 25.4 | 26.0 | 24.0 | 30.3 | 29.2 | 28.9 | 27.3[b] | 27.7[c] |
| May 1970 | 22.9 | 23.8 | 26.0 | 26.8 | 29.5 | 29.2 | 26.4[b] | 27.1[c] |
| Aug. '70 | -- | 24.3 | 25.5 | 26.5 | 29.2 | 26.5 | -- | 26.4[c] |
| Mean All species | 23.4[a] | 25.3[ab] | 25.5[ab] | 26.7[b] | 29.5[c] | 29.5[c] | | |
| Mean Grasses | -- | 24.8[a] | 25.5[a] | 26.1[a] | 29.0[b] | 28.8[b] | | |

The acid detergent fibre content of white clover was only marginally lower than that of the grasses. Cocksfoot had higher levels than ryegrass ($P < 0.05$). Acid detergent fibre contents of all species were lowest in spring and highest in summer ($P < 0.05$).

Table 7  12 hour in vitro digestibility of the six species at each harvest.

12 hour in vitro digestibility (%)

| Harvest date | WC | MR | AR | PR | CC | AC | Mean: All species | Mean: Grasses |
|---|---|---|---|---|---|---|---|---|
| May 1969 | 42.5 | 29.3 | 26.4 | 26.8 | 24.4 | 21.6 | $28.5^{b}$ | $25.7^{b}$ |
| Aug. '69 | — | 27.6 | 24.4 | 31.3 | 25.5 | 26.6 | — | $27.1^{b}$ |
| Sep. - Oct. '69 | 45.6 | 27.3 | 38.3 | 40.3 | 35.6 | 31.1 | $36.4^{a}$ | $34.5^{a}$ |
| Nov. '69 | 40.3 | 41.4 | 35.2 | 34.3 | 24.3 | 30.2 | $34.3^{a}$ | $33.1^{a}$ |
| Jan. '70 | 34.9 | 24.6 | 23.7 | 28.8 | 17.9 | 21.2 | $25.2^{bc}$ | $23.2^{b}$ |
| Mar. '70 | 28.9 | 23.1 | 25.6 | 19.1 | 23.4 | 17.8 | $23.1^{c}$ | $21.8^{b}$ |
| May 1970 | 40.0 | 32.4 | 23.0 | 21.4 | 22.4 | 22.1 | $26.9^{bc}$ | $24.3^{b}$ |
| Aug. '70 | — | 28.3 | 21.8 | 26.2 | 17.9 | 21.9 | — | $23.2^{b}$ |
| Mean All species | $38.7^{a}$ | $29.7^{b}$ | $28.7^{bc}$ | $28.5^{bc}$ | $24.7^{c}$ | $24.0^{c}$ | | |
| Mean Grasses | — | $29.3^{a}$ | $27.3^{ab}$ | $28.5^{a}$ | $23.9^{b}$ | $24.1^{b}$ | | |

White clover had a significantly higher 12 hour in vitro digestibility than the grasses ($P < 0.05$) and cocksfoot tended to have lower values than ryegrass. 12 hour in vitro digestibility was highest in the spring and early summer and was lower in mid summer, autumn and winter ($P < 0.05$).

Relations between dry matter intake and dry matter digestibility

Figure 3 shows the relation between intake (DMI) and digestibility (DMD) for spring - summer, autumn and winter cuts.

The overall relation was:

$DMI = 1.06 DMD + 2.7$, residual standard deviation (RSD) = $\pm$ 8.4, correlation coefficient (r) = 0.48, $P < 0.01$.

Within spring - summer cuts and within winter cuts however, stronger relations occurred. These were:

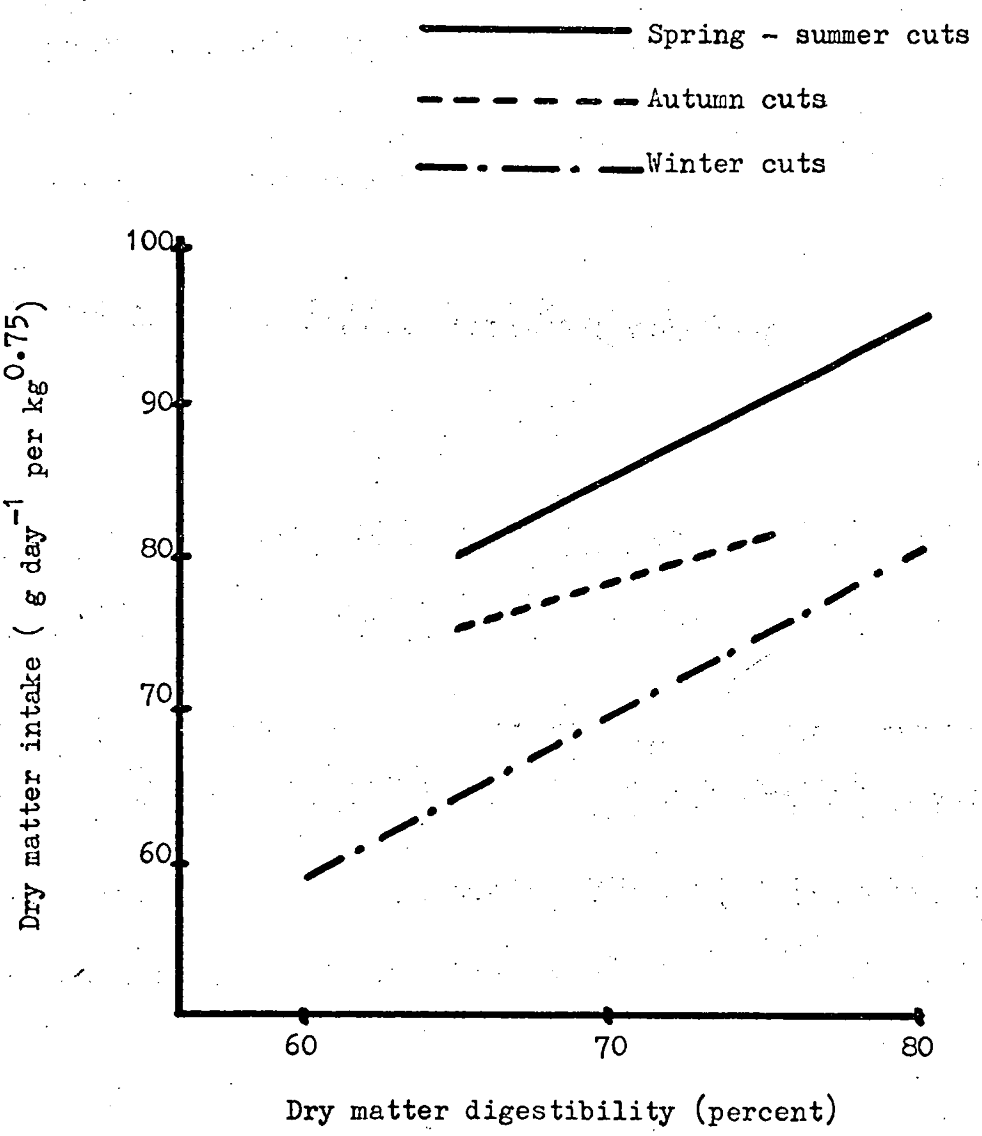
$DMI = 1.01 DMD + 14.6$, RSD = $\pm$ 4.0, r = .81, $P < 0.01$ and

$DMI = 1.08 DMD - 5.9$, RSD = $\pm$ 4.1, r = .72, $P < 0.01$ respectively.

The increased residual standard deviation found with the combined season relation indicates that spring - summer and winter pastures followed different relations between intake and digestibility. The positions but not the slopes of these two regressions differ ($P < 0.01$). Thus, at any digestibility level, the intake of spring - summer pasture was approximately 15 units or 20 % higher than the intake of winter pasture. The intake of autumn pasture was intermediate.

All species showed positive relations between intake and digestibility, and within the spring - summer and winter seasons, these relations were significant ($P < 0.01$) for the grasses but not for white clover. There were no significant species differences in the relation between intake and digestibility ($P < 0.05$). Thus there was no evidence that intake of clover was higher than that of grass at the same digectibility.

Figure 3. Relations between voluntary intake and digestibility



Relations between dry matter intake and chemical composition.

Table 8a shows the relation between DMI and chemical composition measurements for spring - summer, winter and combined season cuts. The relations between intake and digestibility are included as a comparison. Table 8b shows information from the multiple relations found when the chemical composition factors were included in the intake - digestibility relation.

Table 8a. Relations between intake and chemical composition.

Regression equation, residual standard deviation, correlation coefficient and probability level for relations between dry matter intake (DMI) and chemical composition

| where X = | Spring - summer cuts | Winter cuts | All season cuts |
|---|---|---|---|
| CP | DMI = .59X + 76.1<br>± 5.7, r = .53<br>P< 0.01 | DMI = .23X + 66.0<br>± 5.8, r = .12<br>P not significant | DMI = .22X + 73.6<br>± 9.5, r = .12<br>P not significant |
| WSC | DMI = .25X + 82.1<br>± 6.5, r = .28<br>P not significant | DMI = .29X + 66.7<br>± 5.8, r = .18<br>P not significant | DMI = .52X + 70.8<br>± 9.0, r = .33<br>P< 0.01 |
| NDF | DMI =-.47X + 111.4<br>± 3.9, r =-.82<br>P< 0.01 | DMI =-.42X + 91.1<br>± 4.9, r =-.56<br>P< 0.01 | DMI =-.24X + 89.8<br>± 9.3, r =-.23<br>P< 0.05 |
| ADF | DMI =-.92X + 112.1<br>± 3.8, r =-.83<br>P< 0.01 | DMI =-.92X + 93.4<br>± 5.2 r =-.47<br>P< 0.01 | DMI =-.33X + 86.4<br>± 9.4, r =-.16<br>P not significant |
| 12 hr IVD | DMI = .61X + 66.9<br>± 4.5, r = .61<br>P< 0.01 | DMI = .51X + 57.1<br>± 5.1, r = .49<br>P< 0.01 | DMI = .82X + 54.5<br>± 7.5, r = .63<br>P< 0.01 |
| DMD | DMI = 1.01X + 14.6<br>± 4.0, r = .81<br>P< 0.01 | DMI = 1.08X - 5.9<br>± 4.1, r = .72<br>P< 0.01 | DMI = 1.06X + 2.7<br>± 8.4, r = .48<br>P< 0.01 |

CP = crude protein　　WSC = water soluble carbohydrates

NDF = neutral detergent fibre　　ADF = acid detergent fibre

12 hr IVD = 12 hour in vitro digestibility

Table 8b Multiple relations between intake and digestibility and chemical composition (combined season cuts).

Relations between intake (DMI) and digestibility (DMD) with :

| | Multiple correlation coefficient | Residual standard deviation | Significance of adding chemical factor |
|---|---|---|---|
| CP | .48, $P < 0.01$. | $\pm$ 8.4 | P not significant |
| WSC | .54, $P < 0.01$. | $\pm$ 8.1 | $P < 0.05$ |
| NDF | .51, $P < 0.01$. | $\pm$ 8.2 | P not significant |
| ADF | .54, $P < 0.01$. | $\pm$ 8.1 | $P < 0.05$ |
| 12 hr IVD | .64, $P < 0.01$. | $\pm$ 7.4 | $P < 0.01$ |

Crude protein content of forages was related to intake within spring - summer cuts but there was no significant relation with winter cuts or when all season cuts were combined. In the combined season data, inclusion of crude protein did not improve the relation between intake and digestibility.

Within seasons there was no relation between water soluble carbohydrate content and intake, however, with the combined season data a relation did exist. Water soluble carbohydrate content was significantly related to intake at constant digestibility and inclusion of soluble carbohydrate data marginally reduced the residual standard deviation of the intake - digestibility relation.

Detergent fibre level in forages was related to intake within both spring - summer and winter seasons, and detergent fibre was a better predictor of intake of spring - summer cuts than was digestibility. However, in the combined season data, relations between intake and detergent fibre were weaker and had higher residual standard deviations than the intake - digestibility relation. Inclusion of detergent fibre, especially acid detergent fibre in the intake - digestibility relation caused a small reduction in residual variability.

12 hour in vitro digestibility was strongly related to intake within seasons and overall. It was less reliable than digestibility in predicting intake within seasons but was a better predictor in the combined season data. Inclusion of 12 hour in vitro digestibility in the intake - digestibility relation gave the greatest reduction in variability.

## DISCUSSION TRIAL 1

### Differences between species

The differences found in this trial are consistent with other reported results. White clover has consistently been shown to have a higher digestibility and voluntary intake than ryegrass (Joyce and Newth 1967; Hight, Sinclair and Lancaster 1968; Thomson and Raymond 1970; Marsh and Chestnutt 1976). Cocksfoot has often been shown to have a lower digestibility than ryegrass (Minson, Raymond and Harris 1960; Milford and Minson 1966; Alder and Cooper 1967; Greenhalgh and Reid 1969).

### Differences between seasons.

Digestibility levels followed the normal pattern for regrowths over the spring and summer (Minson, Raymond and Harris 1960; Minson et al 1964; Dent and Aldrich 1968) in that there was a fall in the digestibility of the grasses after ear emergence to a relatively stable level over the summer. Voluntary intake also followed the normal pattern over this period and was lower with more mature and lower digestibility forages (Minson et al 1964).

Voluntary intake of winter pasture however was about 20 % lower than spring - summer pasture of the same digestibility and autumn pasture intake was intermediate. There is some information in the literature which indicates that this intake depression on autumn and winter pasture may be relatively common. Demarquilly and Jarridge (1973) reported a greater intake of summer herbage compared with autumn herbage of similar digestibility, Lonsdale and Taylor (1972) found intake of autumn pasture was about 11 % lower than that of spring pasture of similar digestibility. Recalculation of the results of Hight et al (1968) with late autumn pasture leads to dry matter intakes of approximately 70 and 80 kg DM $day^{-1}$ per $kg^{0.75}$ for perennial ryegrass and white clover respectively. These results are similar to those found in this trial. Corbett, Langlands and Reid (1963) have reported a low intake by cows grazing autumn pasture compared to spring pasture of similar digestibility and Hennessy (1973) has reported low intakes by steers grazing winter irrigated pasture.

Intake - digestibility relations.

In this trial, there were no significant differences between species in the relation between intake and digestibility and as a result, there was no evidence that any species had a higher intake at a given digestibility than any other species. This was despite the fact that white clover had a significantly lower neutral detergent fibre (cell wall) content than the grasses and thus a higher proportion of its dry matter as rapidly digestible cell contents, the factor suggested by Van Soest (1965) as the reason for the higher intake of legumes than grasses. As well as, and possibly due to the higher proportion of cell contents, white clover had a significantly higher 12 hour in vitro digestibility than the grasses indicating that it was subject to a more rapid rate of digestion.

Thus with these six species, it appeared that voluntary intake, within seasons, could be predicted, and the species could be satisfactorily ranked in terms of voluntary intake on the basis of digestibility information.

The major difference in intake of pastures at a given digestibility occurred between seasons when at any digestibility level, intake of winter pasture was some 15 units lower than that of spring - summer pasture while intake of autumn pasture was intermediate.

Differences in chemical composition between summer and winter pasture were of little value in explaining the seasonal intake difference.

Winter pasture had lower water soluble carbohydrate contents and inclusion of soluble carvohydrates in the relation between intake and digestibility reduced the seasonal difference marginally, as shown by the lower residual standard deviation of the multiple regression equation. However, low soluble carbohydrate content was unlikely to be a major causative factor as late summer pasture also had low levels despite showing a high intake.

Inclusion of detergent fibre, in particular acid detergent fibre in the relation between digestibility and intake also reduced the seasonal difference marginally. However, highest levels of detergent fibre occurred in mid to late summer indicating that it was unlikely to be a major factor causing the low winter intakes.

Inclusion of 12 hour in vitro digestibility results in the intake - digestibility relation caused the largest reduction in residual variability (residual standard deviation reduced from ± 8.4 to ± 7.4 intake units). It appeared therefore that differences between summer and winter pastures in "rate of digestion" at the same "extent of digestion" level played some part in the intake differences found. However, the intake - 12 hour in vitro digestibility relation still showed significant seasonal effects and at any level of 12 hour in vitro digestibility, intake of winter pasture was approximately 13 units lower than that of spring - summer pasture. Only a small part of the seasonal intake difference therefore, could be attributed to seasonal differences in rate of digestion as measured by 12 hour in vitro digestibility.

The relation between intake and digestibility appeared to be linear over the whole range of digestibility. For example, the intake - digestibility relation for pastures above 70 % digestibility in spring - summer harvests was :

$$DMI = 1.01DMD + 14.3, \ P < 0.01,$$

which was virtually identical with the full regression using samples covering the full range of digestibility. This agrees with the results of Osbourne et al (1966) indicating that metabolic, as distinct from gastro - intestinal fill, mechanisms were not important determinants of intake with these forages.

CONCLUSION TRIAL 1

Within seasons, voluntary intake of all the species was closely related to digestibility and there was no evidence of different species having different intakes when fed at the same digestibility. Thus intake of all the species could be reliably predicted from knowledge of their digestibility.

The low intake of winter pasture at any digestibility level indicated the presence of an undefined intake determining mechanism. The intake difference could not be explained as being due to a difference in crude protein, water soluble carbohydrate or detergent fibre contents and could only be partly explained in terms of a difference in the rate of digestion as measured by 12 hour in vitro digestibility.

In this trial, cuts from only one harvest were fed in any one feeding trial, thus summer pastures were fed in the summer and winter pastures were fed in the winter. Gordon (1964) found what appeared to be a seasonal effect on the roughage intake of penned sheep leading to high intakes in the summer and low intakes in the winter. Results from this trial do not eliminate the possibility that the low winter intakes were caused by animal metabolic factors rather than by feed factors.

RESULTS TRIAL 2

Tables 9 and 10 show mean dry matter digestibility and voluntary intake results for the four species over three harvests.

Table 9 Dry matter digestibility of the four species at three harvests.

Dry matter digestibility (%) and (average days regrowth)

| Harvest date | MR | IR | TR | O | Mean |
| --- | --- | --- | --- | --- | --- |
| April - May 1973 | 75.0 (46) | 72.1 (44) | 73.3 (44) | 73.6 (45) | 73.5[a] |
| July | 73.9 (79) | 75.3 (79) | 77.2 (79) | 67.3 (77) | 73.4[a] |
| October | 78.0 (63) | 75.8 (63) | 78.4 (63) | 76.5 (61) | 77.2[a] |
| Mean | 75.6[a] | 74.4[a] | 76.3[a] | 72.5[a] | |

MR = manawa ryegrass IR = Italian ryegrass

TR = Tama ryegrass O = oats

[a] Means with the same letter do not differ ($P < 0.05$)

There were no significant differences in digestibility between species or between harvests.

Table 10 Voluntary intake of the four species at three harvests.

Dry matter intake g day$^{-1}$ per kg$^{0.75}$

| Harvest date | MR | IR | TR | O | Mean |
|---|---|---|---|---|---|
| April - May 1973 | 76.0 | 78.0 | 76.4 | 75.9 | 76.6$^{b}$ |
| July | 74.8 | 74.1 | 74.3 | 72.2 | 73.9$^{b}$ |
| October | 83.0 | 83.9 | 84.2 | 86.6 | 84.4$^{a}$ |
| Mean | 77.9$^{a}$ | 78.7$^{a}$ | 78.3$^{a}$ | 78.2$^{a}$ | |

No significant differences occurred in voluntary intake between species. However, intake in the October (spring) harvest was significantly higher than intake in the April - May and July harvests ($P < 0.01$).

In the April - May harvest, after completion of harvesting of the first block of four species, because of the Easter holiday and a period of wet weather, there was a delay of about two weeks before harvesting of the second block commenced. Over this period, a significant fall in voluntary intake occurred. Table 11 shows the dry matter digestibility and voluntary intake results for the individual cuts in that harvest and also shows date of harvest.

Table 11 Dry matter digestibility and intake of the individual cuts in the April - May harvest.

| | Harvest date | Species | Digestibility (%) | Intake g $day^{-1}/kg^{0.75}$ |
|---|---|---|---|---|
| Block 1 | 13.4.73 | O | 75.3 | 81.5 |
| | 16.4 | MR | 75.8 | 82.3 |
| | 17.4 | IR | 71.6 | 87.7 |
| | 18.4 | TR | 73.2 | 77.7 |
| | Mean | | $74.0^a$ | $82.3^a$ |
| Block 2 | 1.5.73 | TR | 73.4 | 75.0 |
| | 3.5 | IR | 72.6 | 68.2 |
| | 7.5 | MR | 74.2 | 69.6 |
| | 8.5 | O | 71.8 | 70.2 |
| | Mean | | $73.0^a$ | $70.8^b$ |

There was no significant difference in digestibility between the two blocks but voluntary intake of cuts in the second (May harvested) block was significantly lower ($P < 0.05$).

Tables 12, 13, 14 and 15 show crude protein, water soluble carbohydrate, neutral detergent fibre and acid detergent fibre results for the four species over the three harvests.

Table 12 Crude protein contents of the four species at three harvests.

Crude protein (%)

| Harvest date | MR | IR | TR | O | Mean |
|---|---|---|---|---|---|
| April - May 1973 | 24.8 | 25.5 | 26.2 | 24.1 | 25.2[a] |
| July | 20.0 | 22.9 | 22.9 | 19.4 | 21.3[a] |
| October | 14.1 | 14.1 | 13.2 | 13.1 | 13.6[b] |
| Mean | 19.6[a] | 20.8[a] | 20.8[a] | 18.9[a] | |

There were no significant differences between species in crude protein content but levels were lower in the October harvest ($P < 0.05$).

Table 13 Water soluble carbohydrate contents of the four species at three harvests.

Water soluble carbohydrates (%)

| Harvest date | MR | IR | TR | O | Mean |
|---|---|---|---|---|---|
| April - May 1973 | 9.2 | 8.5 | 10.3 | 11.2 | 9.8[c] |
| July | 14.2 | 13.3 | 13.3 | 17.1 | 14.5[b] |
| October | 19.5 | 20.0 | 23.2 | 29.7 | 23.1[a] |
| Mean | 14.3[b] | 13.9[b] | 15.6[b] | 19.3[a] | |

Oats had a higher soluble carbohydrate content than the ryegrasses ($P < 0.05$) and there were no significant differences between the ryegrasses. Levels were highest in the October harvest and lowest in the April - May harvest ($P < 0.05$).

Table 14 Neutral detergent fibre contents of the four species at three harvests.

Neutral detergent fibre (%)

| Harvest date | MR | IR | TR | O | Mean |
|---|---|---|---|---|---|
| April - May 1973 | 42.3 | 41.3 | 40.8 | 43.6 | 42.0[a] |
| July | 41.3 | 41.9 | 39.9 | 45.6 | 42.2[a] |
| October | 46.8 | 46.3 | 42.6 | 40.0 | 43.9[a] |
| Mean | 43.5[a] | 43.2[a] | 41.1[a] | 43.1[a] | |

There were no significant differences between species or between harvests in neutral detergent fibre.

Table 15 Acid detergent fibre contents of the four species at three harvests

Acid detergent fibre (%)

| Harvest date | MR | IR | TR | O | Mean |
|---|---|---|---|---|---|
| April - May 1973 | 23.0 | 22.3 | 22.2 | 25.2 | 23.2[b] |
| July | 19.9 | 19.8 | 19.3 | 21.3 | 20.1[a] |
| October | 24.5 | 24.6 | 23.1 | 21.2 | 23.4[b] |
| Mean | 22.5[a] | 22.2[a] | 21.5[a] | 22.6[a] | |

There were no significant species differences in acid detergent fibre however, levels were lowest in the July harvest ($P < 0.05$).

DISCUSSION TRIAL 2

There were no significant differences between species in digestibility or voluntary intake. In contrast with the results of Osbourne et al (1966) and Thomson (1971), intake of the tetraploid (Tama) ryegrass was not lower than that of the diploid (Italian) ryegrass.

Although there were no significant differences between harvest in digestibility, voluntary intake was lowest in the winter harvest and was highest in the spring harvest. As in the first trial, this winter intake depression was not associated with differences in crude protein, water soluble carbohydrate or detergent fibre contents.

In the April - May harvest, block 1 was harvested in mid April and block 2 was harvested in early May. Significant differences occurred between the blocks in voluntary intake though not in digestibility. These results have significance in that all the cuts from this harvest were fed out in one feeding trial indicating that the difference in voluntary intake could not have been caused by animal metabolic factors but must have been due to some characteristic of the feed.

Intakes found with the first block cuts were similar to those found on the autumn cuts in Trial 1 and intakes of the second block cuts were similar to the winter intake levels in Trial 1. It appears therefore that by chance the April - May harvest was carried out over a transition period during which pastures changed from characteristics typical of autumn pasture to characteristics typical of winter pasture.

Over this period there was also a fall in water soluble carbohydrate contents and a rise in detergent fibre contents (see appendix 1, cuts 134 to 141). However, these changes in chemical composition did not appear to have any direct causal effect on intake as soluble carbohydrate levels had risen and detergent fibre levels had fallen by the July harvest whereas intake remained low.

RESULTS · TRIAL 3

Perennial ryegrass and demeter fescue

Tables 16 and 17 show the dry matter digestibility and intake results for the two species over four harvests.

Table 16 Dry matter digestibility of two species at four harvests.

Dry matter digestibility (%) and (days regrowth)

| Harvest date | Perennial ryegrass | Demeter fescue | Mean |
|---|---|---|---|
| October 1974 | 74.8 (150) | 72.4 (150) | 73.6[a] |
| May 1975 | 68.0 (72) | 67.6 (75) | 67.8[a] |
| August | 72.3 (107) | 71.6 (107) | 71.9[a] |
| October | 70.6 (53) | 67.1 (53) | 68.8[a] |
| Mean | 71.4[a] | 69.7[a] | |

[a] Means with the same letter do not differ ($P < 0.05$).

There was no significant difference in digestibility between species or between harvests.

Table 17 Dry matter intake of two species at four harvests.

Dry matter intake g $day^{-1}/kg^{0.75}$

| Harvest date | Perennial ryegrass | Demeter fescue | Mean |
|---|---|---|---|
| October 1974 | 87.7 | 88.5 | 88.1[a] |
| May 1975 | 68.3 | 79.8 | 74.1[b] |
| August | 75.9 | 77.8 | 76.9[b] |
| October | 90.2 | 85.4 | 87.8[a] |
| Mean | 80.5[a] | 82.9[a] | |

Overall there were no significant differences in intake between the two species. Within winter cuts, fescue tended to have a higher intake than ryegrass, especially in the May 1975 harvest, however, the difference was not significant ($P < 0.05$). Intake of winter cuts was significantly less than that of the spring cuts ($P < 0.05$).

Tables 18, 19, 20 and 21 show crude protein, water soluble carbohydrate, neutral detergent fibre and acid detergent fibre results for the two species.

Table 18 Crude protein levels (%)

| Harvest date | Perennial ryegrass | Demeter fescue | Mean |
|---|---|---|---|
| October 1974 | 16.0 | 18.8 | $17.4^{a}$ |
| May 1975 | 12.0 | 12.4 | $12.2^{b}$ |
| August | 18.3 | 20.2 | $19.3^{a}$ |
| October | 9.9 | 14.6 | $12.3^{b}$ |
| Mean | $14.1^{a}$ | $16.5^{a}$ | |

There were no significant differences between species however, crude protein levels were lower in the May 1975 and October 1975 harvests ($P < 0.05$).

Table 19 Water soluble carbohydrate levels (%)

| Harvest date | Perennial ryegrass | Demeter fescue | Mean |
|---|---|---|---|
| October 1974 | 22.1 | 19.8 | $21.0^{a}$ |
| May 1975 | 13.2 | 18.0 | $15.6^{ab}$ |
| August | 14.4 | 12.2 | $13.3^{b}$ |
| October | 23.0 | 19.8 | $21.4^{a}$ |
| Mean | $18.2^{a}$ | $17.5^{a}$ | |

No significant differences occurred between species but soluble carbohydrate levels were lower in the winter than in the spring ($P < 0.05$ for the August harvest).

Table 20 Neutral detergent fibre level (%)

| Harvest date | Perennial ryegrass | Demeter fescue | Mean |
|---|---|---|---|
| October 1974 | 47.4 | 46.9 | 47.2[a] |
| May 1975 | 51.9 | 50.1 | 51.0[a] |
| August | 48.4 | 46.9 | 47.7[a] |
| October | 47.3 | 51.5 | 49.4[a] |
| Mean | 48.8[a] | 48.9[a] | |

Table 21 Acid detergent fibre levels (%)

| Harvest date | Perennial ryegrass | Demeter fescue | Mean |
|---|---|---|---|
| October 1974 | 24.2 | 24.6 | 24.4[a] |
| May 1975 | 28.8 | 28.0 | 28.4[a] |
| August | 25.6 | 26.0 | 25.8[a] |
| October | 24.9 | 29.5 | 27.2[a] |
| Mean | 25.9[a] | 27.0[a] | |

There were no significant differences in neutral detergent or acid detergent fibre either between species or between harvests.

Lucerne

Table 22 shows the dry matter digestibility and intake results for the seven lucerne harvests. In the February 1976, October 1976 and February 1977 harvests, about two thirds of each plot was allowed to grow on until the next harvest date. As a result, short and long regrowth cuts were taken in April 1976, December 1976 and March 1977.

Table 22 Dry matter digestibility (%), dry matter intake ($g\ day^{-1}/kg^{0.75}$) and (days regrowth)

| Date | Digestibility | | Intake | |
|---|---|---|---|---|
| | Short regrowth | Long regrowth | Short regrowth | Long regrowth |
| January 1976 | 58.9 (66) | — | 78.6 | — |
| February | 66.3 (31) | — | 84.1 | — |
| April | 66.5[a] (39) | 56.5[b] | 80.5[a] | 79.1[a] |
| October | 70.2 (188) | — | 93.5 | — |
| December | 67.0[a] (41) | 61.4[a] (234) | 89.4[a] | 88.6[a] |
| February 1977 | 60.5 (59) | — | 93.6 | — |
| March | 65.5[a] (45) | 55.2[b] (102) | 84.1[a] | 69.7[b] |

[a] Means, at the same date, with the same letter do not differ ($P < 0.05$)

Digestibility of lucerne was lower than that normally found with the grasses and digestibility of vegetative short regrowth in the spring peaked at about 70 %. By the time flowering had commenced, digestibility had consistently declined to about 60 %.

Despite the moderate digestibility level, voluntary intake of lucerne cuts was generally high and in the April and December 1976 harvests, the lower digestibility of the long regrowth cuts was not associated with a corresponding fall in intake.

Tables 23 and 24 show the crude protein, water soluble carbohydrate and detergent fibre results for the lucerne cuts.

<u>Table 23</u> Crude protein and water soluble carbohydrate levels.

| | Crude protein (%) | | Water soluble carbohydrates (%) | |
|---|---|---|---|---|
| Date | Short regrowth | Long regrowth | Short regrowth | Long regrowth |
| January 1976 | 10.9 | — | 12.5 | — |
| February | 13.3 | — | 8.4 | — |
| April | 21.1 | 16.2 | 8.9 | 7.1 |
| October | 21.4 | — | 13.3 | — |
| December | 15.1 | 13.4 | 9.6 | 10.7 |
| February 1977 | 14.0 | — | 10.0 | — |
| March | 18.6 | 13.5 | 9.3 | 7.5 |

Table 24 Neutral and acid detergent fibre levels.

| Date | Neutral detergent fibre (%) | | Acid detergent fibre (%) | |
|---|---|---|---|---|
| | Short regrowth | Long regrowth | Short regrowth | Long regrowth |
| January 1976 | 58.1 | — | 41.6 | — |
| February | 44.2 | — | 31.9 | — |
| April | 42.9 | 53.3 | 31.9 | 40.0 |
| October | 39.6 | — | 26.7 | — |
| December | 51.7 | 57.8 | 36.9 | 40.2 |
| February 1977 | 50.2 | — | 37.1 | — |
| March | 41.9 | 56.5 | 32.0 | 42.6 |

There was no consistent seasonal pattern in chemical composition however, the more mature samples tended to have lower crude protein and higher detergent fibre contents.

Relations between intake and digestibility.

Perennial ryegrass and demeter fescue

Significant seasonal differences occurred in the relation between dry matter intake and dry matter digestibility. The relation for spring harvests :

$$DMI = .78DMD + 32.6, \pm 4.7, r = .54, P < 0.05,$$

was significantly different ($P < 0.05$) from the winter regression :

$$DMI = 1.05DMD + 1.8, \pm 6.2, r = .48, \text{ not significant.}$$

Within winter harvests, intake of fescue tended to be higher than that of ryegrass at a similar digestibility and the difference in position of the two regressions was almost significant ($P < 0.10$). There were no species differences in the relation within spring harvests.

The overall regression between intake and digestibility for the ryegrass and fescue cuts was :

$$DMI = 1.27DMD - 8.2, \quad \pm 7.8, \quad r = .48, \quad P < 0.05.$$

Lucerne

The overall regression between intake and digestibility for the lucerne cuts was :

$$DMI = .87DMD + 29.2, \quad \pm 6.1, \quad r = .60, \quad P < 0.05.$$

DISCUSSION TRIAL 3

There were no significant differences in digestibility or voluntary intake between perennial ryegrass and fescue, although intake of fescue tended to be higher in the winter. Minson et al (1964) found that digestibility of fescue was generally lower than that of Italian ryegrass and hybrid ryegrass and that fescue followed a similar intake - digestibility relation to the other grasses. In North America, tall fescue is reported to be similar in digestibility to other temperate grass species but intake has been reported to be more variable, possibly due to the presence of alkaloids (Buckner, Bush and Burrus (1973).

Joyce and Brunswick (1972) measured digestibility and voluntary intake of lucerne at varying stages of maturity from early vegetative to flowering and found that organic matter digestibility fell from about 76 % to 63 % with increasing maturity and that voluntary intake declined with decreasing digestibility. In the present trial, a similar range of digestibility levels were found but the decline in intake with reduced digestibility appeared to be less regular. For example, at two out of three harvests, intake of long regrowth lucerne was similar to that of short regrowth lucerne despite a lower digestibility. As well, there were two cases of a high intake on low digestibility cuts.

In many cases, high levels of animal production have been achieved by animals grazing lucerne (review by Thomson 1978) which is surprising considering the rather low digestibility of lucerne in these trials. Measurements by Christian, Jones and Freer (1970) and Fletcher (1976) have shown that the decline in digestibility of whole plant lucerne is almost wholly due to a decline in digestibility of the stem fraction. Digestibility of leaf remains high and high levels of animal production therefore would be likely in situations of low grazing pressure when animals would be able to selectively graze leaf material.

RESULTS TRIALS 1 to 3 THE OVERALL RELATIONS BETWEEN DRY MATTER INTAKE AND DIGESTIBILITY AND CHEMICAL COMPOSITION

In all three trials, seasonal differences occurred in the intake - digestibility relation. As a result, species differences have been evaluated within seasons and seasonal differences in the relation have been evaluated within grass cuts.

Differences between species

Within spring and summer cuts, there was no significant difference in the relation between intake and digestibility for grasses

$$\text{DMI} = .64\text{DMD} + 39.2, \pm 4.8, \quad r = .56, \quad P < 0.01,$$

and for clover

$$\text{DMI} = .48\text{DMD} + 56.1, \pm 3.7, \quad r = .51, \quad \text{not significant.}$$

However, the relation for lucerne

$$\text{DMI} = .53\text{DMD} + 54.1, \pm 5.4, \quad r = .42, \quad \text{not significant,}$$

had a significantly different position from the grass ($P < 0.01$) but not the clover relation. These regression lines are shown in figure 4.

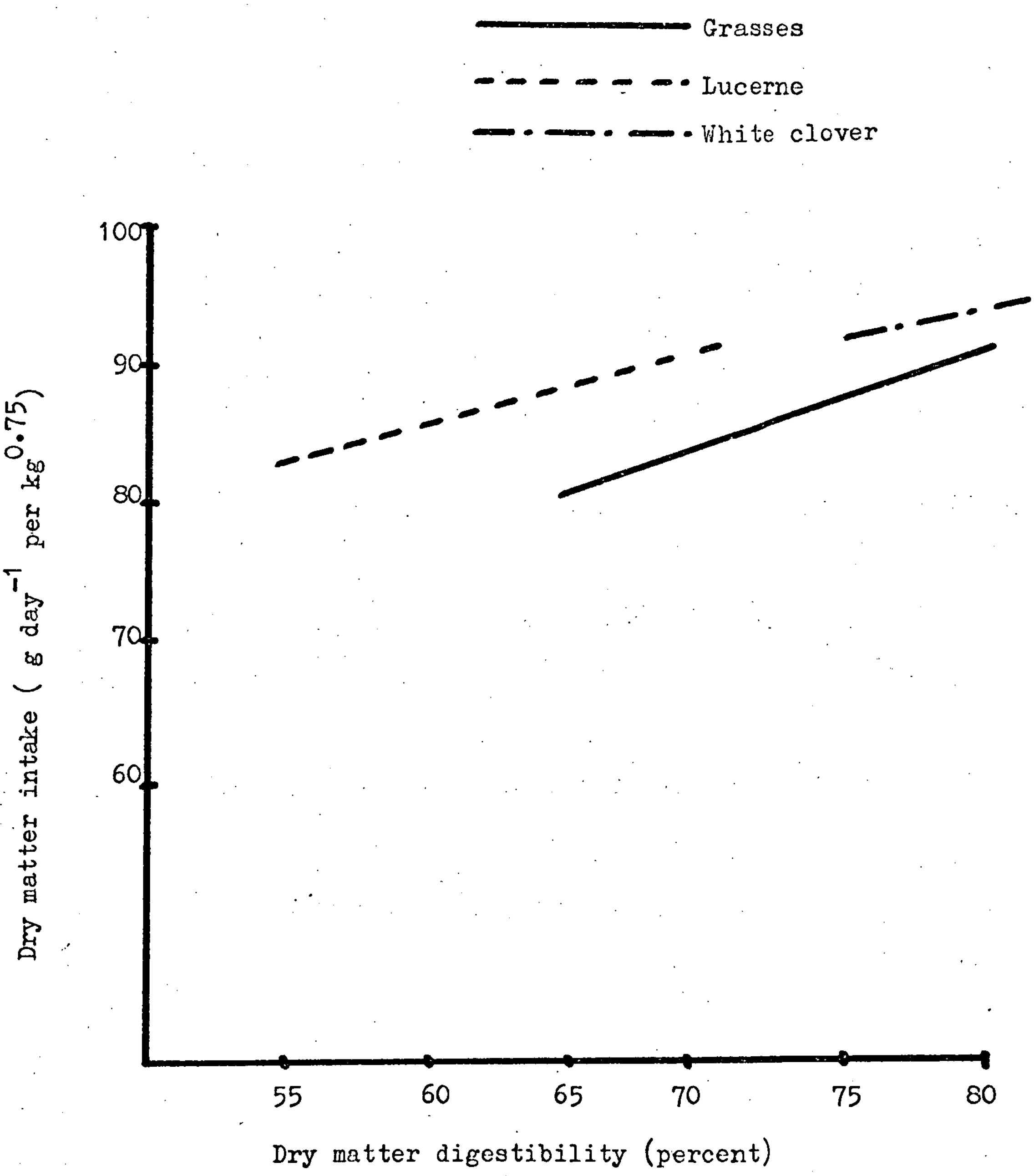
The combined relation for grass plus clover plus lucerne was

$$\text{DMI} = .42\text{DMD} + 56.8, \pm 5.4, \quad r = .42, \quad P < 0.01.$$

However, results from trials 1 and 3 indicated that at any level of digestibility, legumes had a lower level of neutral detergent fibre than the grasses. Multiple regression analysis showed that neutral detergent fibre was significantly related to voluntary intake at constant digestibility ($P < 0.01$). The multiple regression had a residual standard deviation and correlation coefficient of :

$\pm$ 4.5 and $r = .68$ respectively.

Figure 4. Relations between voluntary intake and digestibility, legumes and grasses.



This multiple regression was therefore a better predictor of intake of the mixed species than the intake - digestibility regression. In fact, there was no significant relation between intake and digestibility at constant neutral detergent fibre level indicating that with these species, NDF was a better predictor of intake of spring - summer cuts than was digestibility.

The regression relating dry matter intake with neutral detergent fibre was :

$$DMI = -.42NDF + 108.1, \quad \pm 4.4, \quad r = -.68, \quad P < 0.01.$$

Within winter cuts, the fescue regression

$$DMI = .24DMD + 61.9, \quad \pm 3.1, \quad r = .31, \quad \text{not significant},$$

had a significantly different position ($P < 0.01$) to the ryegrass - cocksfoot regression

$$DMI = .95DMD + 2.9, \quad \pm 4.0, \quad r = .66, \quad P < 0.01.$$

These regression lines are shown in figure 5.

Differences between seasons

The relation between intake and digestibility for spring and summer grasses

$$DMI = .64DMD + 39.9, \quad \pm 4.8, \quad r = .56, \quad P < 0.01,$$

had a different position ($P < 0.01$) from the relation for winter cut grasses

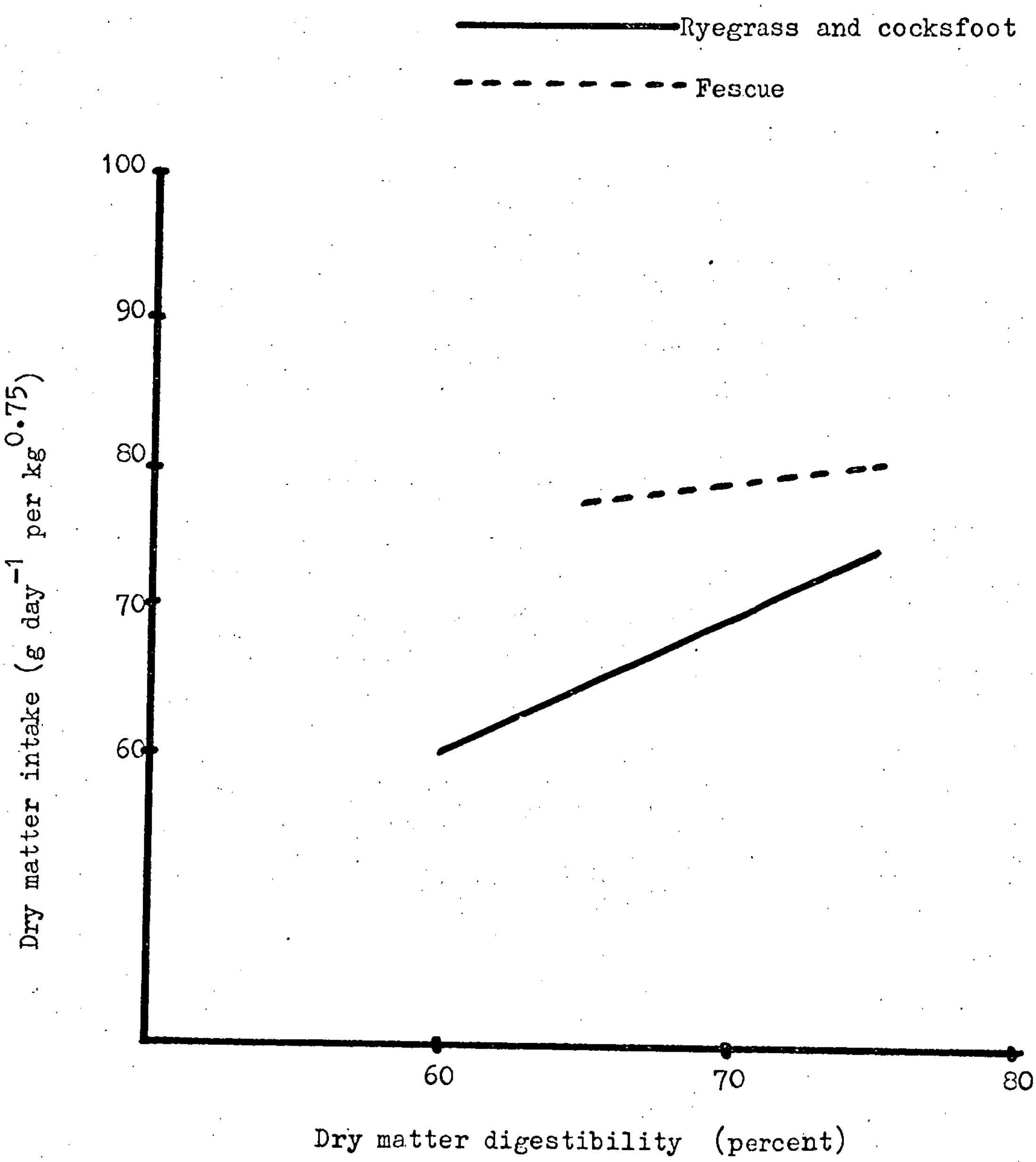
$$DMI = .83DMD + 12.0, \quad \pm 4.7, \quad r = .54, \quad P < 0.01.$$

The relation for autumn cut grasses

$$DMI = .64DMD + 33.8, \quad \pm 3.9, \quad r = .39, \quad \text{not significant},$$

was intermediate.

Figure 5. Relations between voluntary intake and digestibility: winter cuts, differences between grasses.



The combined season relationship for all grasses was :

$$DMI = .78DMD + 23.7, \quad \pm 8.1, \quad r = .36, \quad P < 0.01.$$

The high residual standard deviation is a measure of the seasonal difference that occurred in this relation.

All grass cuts used in the three trials were subjected to similar cutting and bagging treatments. Therefore the weight of material per bag would give some indication of the bulk density of the material as fed. By looking at the net herbage dry matter weight per bag of the different cuts, it was apparent that winter cuts were less dense than spring and summer cuts (values in appendix).

Net weight of grass dry matter per bag (bag weight) was evaluated as a multiple regression factor in the relation between intake and digestibility. Bag weight was significantly related ($P < 0.01$) to voluntary intake at constant digestibility and the residual standard deviation and multiple correlation coefficient was :

$\pm 6.4$ and $r = .67$.

## DISCUSSION TRIALS 1 to 3.

### Factors affecting the voluntary intake of the forages

Within spring - summer cuts, at any digestibility level, lucerne but not clover had a higher voluntary intake than the grasses. By looking at figure 4, it appears that the higher voluntary intake of legumes compared with grasses at a similar digestibility mainly occurs with lower digestibility forages. With forages of 75 - 80 % digestibility ( i.e. the digestibility of white clover), there appeared to be only a minor effect of a higher legume intake. However, at a digestibility of 60 to 70% (i.e. the digestibility of lucerne), there was a significant difference between voluntary intake of grasses and legumes.

With these forages, the difference in intake between grasses and legumes can be explained satisfactorily on the basis that legumes had a lower level of neutral detergent fibre than grasses of a similar digestibility and thus a higher proportion of cell contents. This agrees with the conclusions of Osbourne et al (1966), and indicates that the difference in intake was probably due to physical factors such as rate of digestion and rate of removal of material from the reticulo - rumen.

Within winter cuts, there was a tendency that fescue had a higher intake than ryegrass and cocksfoot of a similar digestibility indicating that the winter intake depression , although occurring with fescue, was not as great as that occurring with the other grasses. This conclusion however should be treated cautiously as measurements were carried out on only four winter fescue cuts and the difference between fescue and the other grasses was statistically significant only when using the combined data of all three trials.

Voluntary intake appeared to be linearly related to digestibility over the full range of digestibility values and there was no evidence that intake with the higher digestibility samples was restricted by non physical factors. This agrees with the results of Osbourne et al (1966).

Within seasons therefore, voluntary intake of these forages could generally be satisfactorily predicted from digestibility information. The exceptions were lucerne and to a lesser extent white clover in spring - summer cuts, and fescue in winter cuts.

In all trials, consistent evidence occurred of a winter intake depression, and voluntary intake of winter pasture was approximately 20 % less than that of spring - summer pasture of a similar digestibility. Intake of autumn pasture was intermediate. Results from trial 2, when pasture equivalent to autumn and winter types was fed in the same feeding trial, indicated that the seasonal intake difference was a true feed effect and was not due to the action of factors such as low temperature or short day lengths (Forbes et al 1975) causing seasonal changes in circulationg hormone levels and animal intake.

Results from trial 1 indicated that winter pasture tended to have lower water soluble carbohydrate levels and higher acid detergent fibre levels. However, incorporation of these factors in a multiple regression with digestibility caused only marginal reductions in the residual standard deviation of the regression predicting intake. These measurements therefore were of little value in indicating causal mechanisms.

In vitro digestibility values after a 12 hour digestion were slightly better at predicting seasonal differences in intake at a given digestibility and inclusion of this factor in the relation between intake and digestibility reduced the overall residual standard deviation from $\pm$ 8.4 to $\pm$ 7.4 intake units. Rate of digestion therefore appeared to play some part in the winter intake depression.

Within winter cuts, although intake was depressed, there was still a strong positive relation between intake and digestibility. This leads to the conclusion that the probable cause of the winter intake depression still involved some physical mechanism of gastro - intestinal capacity rather than a tissue deficiency or intoxication mechanism.

The best predictor of voluntary intake was a multiple regression involving digestibility and feed density, as measured by the weight of chaffed herbage dry matter per bag. The residual standard deviation in this case was reduced to $\pm$ 6.4 intake units. At the design stage of the experiment, no consideration was given to using bag weight as a measure of density and no special emphasis was placed on ensuring an equal packing effort for each cut. However, there should not have been any reason for a bias in packing treatment between species or between seasons.

These results indicate that density of packing of herbage in the reticulo - rumen, as reported by Thornton and Minson (1973) may have been an important factor causing the difference in intake of spring - summer and winter pastures.

Subsequently, an attempt was made to develop a laboratory density measurement using ground (1 mm screen) samples. However, with these ground samples there was no relation between density and season of harvest. It appears therefore, that the physical factor causing the reduced density operates only with long or coarsely chopped material and as a result, the reduced intake on autumn and winter pastures may not occur with finely ground material. Some support for this comes from the results of Lonsdale and Taylor (1972) who found that the intake difference between autumn and spring pasture was reduced on milled pasture.

Results form trial 1 give some evidence that intake of winter clover was less than that of spring - summer clover of similar digestibility. Digestibility of autumn and winter cut clover was high (76.9 %) but intake (81 g $day^{-1}/kg^{0.75}$) was lower than would be expected from spring - summer cuts. However, this conclusion must be tentative because only one autumn and two winter cuts of clover were obtained.

## Value of voluntary intake measurements in predicting animal production in grazing situations

Voluntary intake measurements from indoor feeding trials will only be useful if they can be used to explain and predict the level of animal production that is achieved in field grazing situations, only if differences in voluntary intake that are found in indoor feeding trials actually lead to differences in animal production.

Many grazing trials have shown differences in the level of animal production achieved on different forage species in situations where feed quantity was not limiting.

Animal production is consistently higher on legume dominant compared with grass dominant pasture (McLean et al 1962; Rae et al 1963; Rae, Brougham and Barton 1964; Hight and Sinclair 1965; Gallagher, Watkin and Grimes 1966; Wilson 1966; Grimes, Watkin and Gallagher 1967; Hight and Sinclair 1967; Ulyatt 1969, 1971; Nicol and McLean 1970; Hight et al 1972; Reed, Snaydon and Axelsen 1972; Corbett et al 1976; Archer 1980) and when measurements were made, intake was normally higher on the legume dominant pasture (McLean et al 1962; Grimes, Watkin and Gallagher 1967; Ulyatt 1969, 1971; Corbett et al 1976). However, part of the superiority of legumes has been attributed to a more efficient utilisation of dietary energy in some cases (Rattray and Joyce 1974; Joyce and Newth 1967) but not in others (Graham 1969).

A number of grazing trials in New Zealand have shown consistently that sheep liveweight gain was higher on short rotation ryegrass than on perennial ryegrass (Rae et al 1963; Rae, Brougham and Barton 1964). The animal production difference in this case does not appear to be due to differences in voluntary intake (Ulyatt 1969), a conclusion which is consistent with the voluntary intake measurements in this trial. The differences in animal production have been attributed to differences in site of digestion in that a higher proportion of the short rotation ryegrass was digested in the intestine and this was considered to lead to a more efficient energy utilisation (Ulyatt and McRae 1971).

There is increasing evidence of reduced levels of production of animals grazing autumn and winter pasture (review by Reed 1978; Corbett, Langlands and Reid 1963; Large and Spedding 1965; Hodgson and Spedding 1966; Leaver 1974; Hennessy 1973; Marsh 1975; Archer 1980). When measurements have been made, there was normally a reduced or low voluntary intake on these pastures (Corbett, Langlands and Reid 1963, Hodgson and Spedding 1966; Hennessy 1973; Marsh 1975), however, part of the reduced animal production is probably due to a reduced efficiency of utilisation of dietary energy (Corbett et al 1966; Blaxter et al 1971; Lonsdale and Taylor 1972).

The differences in animal production found on legumes compared with grass and the low levels of animal production found on autumn and winter pasture are consistent with the voluntary intake measurements in the present trials, and the differences can largely be attributed to intrinsic factors in the herbages that cause differences in voluntary intake.

Measurement of voluntary intake using penned sheep fed mechanically harvested material therefore, gives information of pasture characteristics that:

1) vary from forage to forage to a significant extent,

2) follow distinct and repeatable patterns that can be explained and predicted, and

3) are important in determining the level of animal production achieved under field situations.

No single measure such as voluntary intake can be expected to explain fully the animal production results that occur in the complex of the grazing system, however, information from these intake trials do provide a measure of one of the most important factors affecting the level of animal production in this complex.

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APPENDIX Data for the Individual Cuts.

| Cut No. | Date | Species | Days regrowth | CP | WSC | NDF | ADF | DM | 12 hr. IVD | DMD | DMI | Bag Wt. (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 6.5.69 | MR | 33 | 16.6 | 14.0 | 43.0 | 20.0 | 21.4 | 29.9 | 74.9 | 72.2 | 5.7 |
| 34 | 8.5 | PR | 35 | 17.4 | 15.0 | 46.4 | 25.4 | 22.6 | 27.5 | 70.3 | 63.7 | 5.9 |
| 35 | 9.5 | WC | 36 | 24.8 | 9.0 | 28.9 | 18.6 | 18.0 | 42.5 | 76.6 | 81.0 | - |
| 36 | 12.5 | AR | 39 | 18.4 | 11.0 | 43.9 | 23.3 | 20.9 | 26.4 | 71.6 | 65.7 | 5.9 |
| 37 | 13.5 | AC | 40 | 21.5 | 7.5 | 52.0 | 28.5 | 21.8 | 21.6 | 61.5 | 61.4 | 5.1 |
| 38 | 14.5 | CC | 41 | 21.2 | 7.5 | 45.1 | 24.5 | 15.3 | 24.4 | 70.6 | 65.0 | 5.3 |
| 39 | 15.5 | MR | 42 | 15.7 | 15.0 | 45.4 | 23.0 | 16.0 | 28.6 | 69.7 | 71.0 | 6.1 |
| 40 | 19.5 | PR | 46 | 17.9 | 14.0 | 43.4 | 24.5 | 18.8 | 26.0 | 70.4 | 67.6 | 6.0 |
| 41 | 31.7.69 | MR | 72 | 15.0 | 14.2 | 43.5 | 20.9 | 17.6 | 28.0 | 75.7 | 75.3 | 5.6 |
| 42 | 5.8 | AC | 77 | 17.8 | 7.4 | 50.4 | 27.0 | 17.0 | 28.3 | 67.8 | 64.4 | 4.8 |
| 43 | 6.8 | AR | 78 | 14.1 | 10.4 | 49.8 | 25.2 | 17.9 | 25.0 | 69.2 | 70.1 | 5.4 |
| 44 | 13.8 | PR | 85 | 14.6 | 12.4 | 45.3 | 24.0 | 24.8 | 30.2 | 74.8 | 74.8 | 5.5 |
| 45 | 14.8 | CC | 86 | 18.0 | 7.3 | 49.5 | 25.8 | 19.3 | 22.4 | 72.9 | 70.8 | 5.8 |
| 46 | 15.8 | AR | 87 | 14.6 | 11.4 | 46.6 | 25.6 | 19.9 | 23.7 | 70.6 | 70.6 | 5.5 |
| 47 | 18.8 | MR | 90 | 17.8 | 16.3 | 43.4 | 23.7 | 15.4 | 27.2 | 76.8 | 76.3 | 5.6 |
| 48 | 19.8 | AC | 91 | 16.6 | 10.8 | 43.0 | 26.8 | 17.3 | 24.9 | 71.8 | 75.5 | 5.7 |
| 49 | 20.8 | CC | 92 | 16.1 | 13.0 | 43.3 | 25.6 | 23.5 | 28.5 | 72.4 | 76.6 | 6.1 |
| 50 | 21.8 | PR | 93 | 14.6 | 18.6 | 40.8 | 20.0 | 21.5 | 32.3 | 72.5 | 75.2 | 5.8 |

CP = Crude protein (% of dry matter)
NDF = Neutral detergent fibre (% DM)
DM = Dry matter percent as cut
DMD = Dry matter digestibility (%)
WSC = Water soluble carbohydrates (% DM)
ADF = Acid detergent fibre (% DM)
12 hr. IVD = 12 hour in vitro digestibility (%)
DMI = Dry matter intake g/day/kg$^{0.75}$

| Cut No. | Date | Species | Days regrowth | CP | WSC | NDF | ADF | DM | 12 hr. IVD | DMD | DMI | Bag Wt. (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 | 22.9.69 | MR | 28 | 21.6 | 16.8 | 44.3 | 22.4 | 21.0 | 27.3 | 74.4 | 84.3 | 5.8 |
| 52 | 30.9 | AC | 36 | 24.2 | 12.1 | 53.0 | 24.2 | 22.5 | 27.5 | 68.1 | 85.6 | 5.8 |
| 53 | 1.10 | AR | 37 | 18.1 | 21.3 | 47.8 | 24.3 | 24.1 | 31.3 | 72.2 | 85.1 | 6.4 |
| 54 | 2.10 | PR | 38 | 18.7 | 24.1 | 45.5 | 20.2 | 23.9 | 37.9 | 76.0 | 89.2 | 6.6 |
| 55 | 6.10 | CC | 42 | 21.2 | 16.8 | 48.6 | 20.4 | 22.3 | 35.6 | 75.2 | 96.4 | 7.3 |
| 56 | 7.10 | AC | 43 | 22.6 | 18.3 | 49.0 | 21.7 | 24.7 | 34.7 | 74.3 | 93.7 | 6.9 |
| 57 | 8.10 | AR | 44 | 16.7 | 27.6 | 43.5 | 19.7 | 22.6 | 45.2 | 75.9 | 91.2 | 6.9 |
| 58 | 10.10 | PR | 46 | 16.0 | 29.7 | 44.7 | 20.6 | 21.6 | 42.6 | 77.9 | 95.0 | 7.3 |
| 59 | 13.10 | WC | 49 | 21.6 | 10.3 | 27.0 | 19.7 | 12.5 | 45.6 | 81.4 | 100.0 | — |
| 60 | 4.11.69 | MR* | 20 | 16.9 | 25.3 | 45.9 | 21.5 | 19.1 | 43.8 | 71.9 | 90.3 | 6.5 |
| 61 | 6.11 | CC* | 22 | 18.2 | 11.5 | 65.6 | 30.6 | 18.6 | 28.5 | 69.7 | 84.1 | 6.9 |
| 62 | 7.11 | PR* | 23 | 15.6 | 20.5 | 57.7 | 28.6 | 20.0 | 30.3 | 67.7 | 84.0 | 7.1 |
| 63 | 10.11 | AR* | 26 | 15.6 | 21.9 | 57.0 | 26.6 | 22.9 | 33.8 | 70.4 | 91.4 | 6.4 |
| 64 | 11.11 | AC* | 27 | 19.9 | 13.3 | 57.6 | 28.7 | 20.6 | 32.6 | 70.8 | 85.4 | 6.1 |
| 65 | 14.11 | WC* | 30 | 34.4 | 9.2 | 33.2 | 21.3 | 19.4 | 38.7 | 79.7 | 91.1 | — |
| 66 | 20.11 | MR* | 36 | 11.8 | 28.4 | 59.4 | 28.2 | 20.8 | 38.9 | 68.5 | 85.0 | 7.6 |
| 67 | 21.11 | WC* | 37 | 32.5 | 11.1 | 37.0 | 25.1 | 12.1 | 41.8 | 78.3 | 91.9 | — |
| 68 | 24.11 | CC* | 40 | 11.3 | 13.7 | 75.0 | 42.5 | 31.8 | 20.1 | 60.0 | 72.1 | 8.0 |
| 69 | 25.11 | PR* | 41 | 12.5 | 22.8 | 56.3 | 30.4 | 32.1 | 38.2 | 66.4 | 84.0 | 8.0 |
| 70 | 26.11 | AR* | 42 | 11.2 | 24.7 | 58.3 | 30.9 | 26.8 | 36.5 | 64.9 | 78.0 | 8.4 |
| 71 | 27.11 | AC* | 43 | 14.9 | 10.9 | 63.3 | 34.3 | 24.9 | 27.7 | 63.5 | 81.1 | 7.0 |

* Indicates that herbage was in a flowering or reproductive stage.

| Cut No. | Date | Species | Days regrowth | CP | WSC | NDF | ADF | DM | 12 hr. IVD | DMD | DMI | Bag Wt. (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72 | 14.1.70 | AC* | 45 | 14.4 | 4.8 | 64.1 | 35.8 | 19.4 | 23.9 | 66.6 | 74.4 | 5.0 |
| 73 | 18.1 | CC* | 46 | 15.4 | 3.9 | 69.3 | 36.2 | 20.9 | 18.6 | 71.3 | 78.0 | 6.2 |
| 74 | 19.1 | MR* | 50 | 11.2 | 16.5 | 59.5 | 32.5 | 25.0 | 26.4 | 66.5 | 82.9 | 7.1 |
| 75 | 20.1 | AR* | 51 | 11.9 | 12.0 | 62.3 | 28.6 | 25.8 | 25.5 | 71.1 | 85.5 | 6.8 |
| 76 | 21.1 | PR* | 52 | 12.4 | 13.5 | 60.0 | 28.0 | 29.8 | 28.8 | 70.8 | 89.5 | 7.0 |
| 77 | 22.1 | AC* | 53 | 11.0 | 3.9 | 69.0 | 35.3 | 24.6 | 18.4 | 58.5 | 75.6 | 5.5 |
| 78 | 23.1 | WC* | 54 | 18.4 | 8.1 | 36.0 | 29.4 | 15.7 | 36.3 | 75.1 | 91.4 | -- |
| 79 | 27.1 | AR* | 58 | 9.6 | 12.5 | 59.6 | 29.4 | 30.8 | 21.9 | 74.8 | 87.3 | 6.5 |
| 80 | 28.1 | CC* | 59 | 11.4 | 7.3 | 65.9 | 37.2 | 24.9 | 17.1 | 66.2 | 81.0 | 7.8 |
| 81 | 29.1 | MR* | 60 | 7.9 | 16.0 | 64.6 | 34.2 | 34.3 | 22.8 | 72.0 | 77.6 | 8.4 |
| 82 | 30.1 | WC* | 61 | 16.1 | 8.9 | 42.1 | 31.1 | 21.0 | 33.5 | 71.3 | 92.3 | -- |
| 83 | 5.3.70 | AC | 29 | 29.2 | 4.8 | 57.5 | 29.2 | 14.7 | 17.8 | 71.0 | 76.3 | 4.8 |
| 84 | 9.3 | AR* | 33 | 26.9 | 13.6 | 52.6 | 21.8 | 20.1 | 20.2 | 71.2 | 77.3 | 6.1 |
| 85 | 10.3 | PR | 34 | 23.3 | 12.1 | 54.5 | 30.3 | 27.9 | 19.1 | 67.2 | 80.0 | 7.2 |
| 86 | 12.3 | CC* | 36 | 31.1 | 3.2 | 63.5 | 25.2 | 22.5 | -- | 71.8 | 82.5 | 6.7 |
| 87 | 13.3 | WC* | 37 | 35.9 | 4.8 | 46.0 | 25.4 | 17.2 | 28.9 | 73.8 | 79.7 | -- |
| 88 | 16.3 | MR* | 40 | 24.0 | 11.0 | 50.1 | 27.0 | 25.3 | -- | 74.5 | 83.5 | 7.1 |
| 89 | 17.3 | AC | 41 | 22.9 | 2.7 | 61.0 | 28.6 | 24.3 | -- | 69.3 | 77.6 | 5.5 |
| 90 | 18.3 | AR* | 42 | 15.4 | 16.6 | 53.3 | 26.1 | 23.2 | 24.9 | 71.3 | 76.4 | 6.2 |
| 91 | 19.3 | CC* | 43 | 19.8 | 8.6 | 61.0 | 33.2 | 18.1 | 23.4 | 68.6 | 79.4 | 5.0 |
| 92 | 24.3 | MR* | 48 | 20.6 | 15.9 | 53.2 | 25.0 | 17.2 | 23.1 | 69.4 | 72.5 | 5.1 |

| Cut No. | Date | Species | Days regrowth | CP | WSC | NDF | ADF | DM | 12 hr. IVD | DMD | DMI | Bag Wt. (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 93 | 30.4.70 | AC | 37 | 18.2 | 11.3 | 52.3 | 27.8 | 18.4 | 22.1 | 68.8 | 75.1 | 5.1 |
| 94 | 1.5 | CC | 38 | 20.8 | 5.8 | 59.7 | 32.1 | 14.6 | 20.0 | 69.9 | 71.2 | 4.4 |
| 95 | 4.5 | AR | 41 | 17.9 | 14.7 | 52.5 | 22.8 | 24.1 | 23.7 | 72.2 | 69.8 | 5.6 |
| 96 | 5.5 | PR | 42 | 17.3 | 10.3 | 57.7 | 28.1 | 18.7 | 18.3 | 70.8 | 69.1 | 5.8 |
| 97 | 7.5 | MR | 44 | 17.5 | 16.5 | 50.5 | 25.0 | 19.9 | 26.1 | 72.2 | 77.9 | 5.6 |
| 98 | 12.5 | AC | 49 | 16.8 | 4.9 | 66.8 | 30.6 | 17.3 | -- | 64.6 | 63.7 | 4.6 |
| 99 | 13.5 | AR | 50 | 15.4 | 12.2 | 57.5 | 29.2 | 18.3 | 22.3 | 71.1 | 65.8 | 4.1 |
| 100 | 14.5 | PR | 51 | 16.9 | 13.1 | 56.4 | 25.5 | 23.4 | 24.5 | 70.1 | 63.2 | 5.1 |
| 101 | 15.5 | WC | 52 | 26.0 | 7.8 | 30.4 | 22.9 | 15.3 | 40.0 | 80.3 | 83.0 | — |
| 102 | 18.5 | CC | 55 | 19.6 | 9.8 | 58.2 | 26.9 | 23.4 | 24.8 | 72.7 | 77.8 | 5.3 |
| 103 | 19.5 | MR | 56 | 18.1 | 17.1 | 52.0 | 22.6 | 25.0 | 38.6 | 74.4 | 68.0 | 5.9 |
| 104 | 18.8.70 | MR | 90 | 17.0 | 19.3 | 47.2 | 23.1 | 24.3 | 31.8 | 70.9 | 74.5 | 7.0 |
| 105 | 19.8 | AC | 91 | 19.7 | 11.4 | 54.5 | 26.5 | 26.6 | 21.9 | 68.1 | 68.0 | 6.3 |
| 106 | 20.8 | AR | 92 | 18.7 | 13.7 | 52.6 | 24.7 | 25.7 | 19.0 | 69.5 | 71.0 | 6.4 |
| 107 | 21.8 | PR | 93 | 18.1 | 15.8 | 54.0 | 27.9 | 28.5 | 26.9 | 67.7 | 67.6 | 6.9 |
| 108 | 26.8 | CC | 98 | 22.9 | 6.8 | 61.2 | 31.4 | 19.3 | 16.5 | 59.1 | 57.3 | 6.8 |
| 109 | 27.8 | MR | 99 | 14.4 | 15.8 | 51.0 | 25.4 | 19.8 | 24.7 | 70.9 | 61.9 | 6.1 |
| 110 | 28.8 | CC | 100 | 21.6 | 8.8 | 58.6 | 27.0 | 25.6 | 19.2 | 67.6 | 74.0 | 5.1 |
| 111 | 31.8 | PR | 103 | 19.9 | 14.2 | 51.7 | 25.1 | 23.2 | 25.4 | 70.0 | 69.6 | 5.6 |
| 112 | 1.9 | AR | 104 | 19.2 | 11.2 | 54.0 | 26.2 | 23.8 | 24.5 | 68.5 | 63.0 | 5.2 |

| Cut No. | Date | Species | Days regrowth | CP | WSC | NDF | ADF | DM | DMD | DMI | Bag Wt. (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 134 | 12.4.73 | O | 32 | 24.2 | 15.3 | 39.3 | 23.1 | 23.4 | 75.3 | 81.5 | 6.9 |
| 135 | 16.4 | MR | 35 | 24.8 | 12.6 | 38.8 | 21.6 | 21.5 | 75.8 | 82.3 | 7.6 |
| 136 | 17.4 | IR | 36 | 24.5 | 11.2 | 39.2 | 20.3 | 24.0 | 71.6 | 87.7 | 7.5 |
| 137 | 18.4 | TR | 37 | 27.7 | 12.2 | 40.3 | 21.1 | 15.6 | 73.2 | 77.7 | 7.2 |
| 138 | 1.5 | TR | 50 | 24.7 | 8.4 | 41.2 | 23.3 | 12.8 | 73.4 | 75.0 | 4.7 |
| 139 | 3.5 | IR | 52 | 26.5 | 5.8 | 43.4 | 24.3 | 11.0 | 72.6 | 68.2 | 4.4 |
| 140 | 7.5 | MR | 56 | 24.7 | 5.8 | 45.7 | 24.4 | 13.3 | 74.2 | 69.6 | 5.4 |
| 141 | 8.5 | O | 57 | 24.0 | 7.0 | 47.8 | 27.2 | 11.7 | 71.8 | 70.2 | 5.8 |
| 143 | 23.7 | TR | 74 | 21.9 | 15.6 | 40.1 | 18.3 | 14.4 | 77.7 | 77.5 | 6.0 |
| 144 | 24.7 | IR | 75 | 21.9 | 15.0 | 42.2 | 19.0 | 14.5 | 78.0 | 75.4 | 5.5 |
| 145 | 25.7 | MR | 76 | 20.6 | 14.4 | 42.0 | 19.5 | 15.6 | 74.4 | 73.9 | 6.0 |
| 146 | 26.7 | O | 77 | 19.4 | 17.1 | 45.6 | 21.3 | 18.6 | 67.3 | 72.2 | 7.3 |
| 147 | 30.7 | MR | 81 | 19.4 | 14.0 | 40.5 | 20.3 | 17.3 | 73.4 | 75.6 | 6.1 |
| 148 | 31.7 | IR | 82 | 23.8 | 11.6 | 41.6 | 20.5 | 15.2 | 72.6 | 72.8 | 5.6 |
| 149 | 1.8 | TR | 83 | 23.8 | 11.0 | 39.6 | 20.3 | 11.5 | 76.6 | 71.1 | 5.7 |
| 150 | 1.10 | IR | 58 | 14.4 | 17.4 | 45.3 | 23.2 | 18.4 | 76.1 | 84.5 | 6.3 |
| 151 | 2.10 | MR | 59 | 13.8 | 18.0 | 44.0 | 23.1 | 19.1 | 77.6 | 85.8 | 6.7 |
| 152 | 3.10 | TR | 60 | 14.4 | 22.5 | 42.5 | 21.8 | 16.2 | 79.0 | 86.1 | 7.2 |
| 153 | 4.10 | O | 61 | 13.1 | 29.7 | 40.0 | 21.2 | 21.8 | 76.5 | 86.6 | 10.3 |
| 154 | 8.10 | TR | 65 | 11.9 | 23.8 | 42.7 | 24.3 | 16.9 | 77.7 | 82.2 | 6.8 |
| 155 | 9.10 | MR | 66 | 14.4 | 20.9 | 49.5 | 25.9 | 15.8 | 78.3 | 80.2 | 6.3 |
| 156 | 10.10 | IR | 67 | 13.8 | 22.5 | 47.2 | 26.0 | 16.8 | 75.5 | 83.3 | 6.7 |

| Cut No. | Date | Species | Days regrowth | CP | WSC | NDF | ADF | DM | DMD | DMI | Bag Wt. (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 161 | 21.10.74 | PR | 145 | 17.5 | 21.5 | 45.1 | 22.8 | 21.0 | 75.7 | 94.6 | 8.3 |
| 163 | 23.10 | DF | 147 | 20.6 | 21.0 | 44.6 | 22.5 | 21.8 | 76.0 | 94.2 | 8.7 |
| 166 | 29.10 | DF* | 153 | 16.9 | 18.6 | 49.2 | 26.7 | 21.8 | 68.8 | 82.7 | 6.6 |
| 167 | 30.10 | PR | 154 | 14.4 | 22.7 | 49.7 | 25.6 | 19.5 | 73.9 | 80.8 | 7.1 |
| 168 | 5.5.75 | DF | 70 | 12.5 | 19.0 | 49.1 | 28.3 | 24.9 | 67.6 | 80.8 | 7.4 |
| 169 | 6.5 | PR | 71 | 12.6 | 16.0 | 48.8 | 28.0 | 23.8 | 67.6 | 71.0 | 5.9 |
| 170 | 7.5 | PR | 72 | 11.4 | 10.3 | 54.9 | 29.5 | 19.0 | 68.3 | 65.6 | 4.9 |
| 171 | 14.5 | DF | 79 | 12.2 | 16.9 | 51.0 | 27.6 | 20.0 | 67.6 | 78.8 | 6.4 |
| 172 | 28.8.75 | PR | 104 | 16.7 | 12.2 | 50.9 | 27.0 | 21.4 | 70.1 | 68.2 | 4.2 |
| 173 | 29.8 | DF | 105 | 19.5 | 13.3 | 47.5 | 26.9 | 19.2 | 68.6 | 75.1 | 4.9 |
| 174 | 1.9 | DF | 108 | 20.9 | 11.0 | 46.2 | 25.0 | 19.2 | 74.5 | 80.5 | 5.4 |
| 175 | 2.9 | PR | 109 | 19.9 | 16.5 | 45.9 | 24.1 | -- | 74.4 | 83.6 | 5.8 |
| 176 | 27.10.75 | DF* | 51 | 15.8 | 21.5 | 49.7 | 28.9 | 18.9 | 67.2 | 83.7 | 6.6 |
| 177 | 28.10 | PR | 52 | 10.8 | 20.1 | 48.1 | 24.5 | 21.1 | 70.7 | 89.9 | 6.9 |
| 178 | 29.10 | PR | 53 | 8.9 | 25.8 | 46.5 | 25.3 | 20.9 | 70.5 | 90.4 | 6.5 |
| 179 | 30.10 | DF* | 54 | 13.4 | 18.1 | 53.3 | 30.0 | 16.4 | 66.9 | 87.1 | 5.9 |

| Cut No. | Date | Species | Days regrowth | CP | WSC | NDF | ADF | DM | DMD | DMI | Bag Wt. (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 180 | 9.1.76 | L* | 63 | 10.4 | 14.9 | 56.6 | 40.3 | 27.0 | 59.0 | 79.4 | 9.6 |
| 183 | 14.1 | L* | 69 | 11.3 | 10.1 | 59.6 | 42.9 | 24.8 | 58.7 | 77.7 | 12.0 |
| 184 | 18.2 | L | 30 | 15.9 | 8.6 | 42.9 | 31.2 | 24.3 | 64.6 | 83.1 | 11.8 |
| 185 | 20.2 | L | 32 | 10.7 | 8.1 | 45.5 | 32.6 | 19.8 | 68.0 | 85.0 | 11.7 |
| 188 | 1.4 | L | 36 | 20.7 | 8.6 | 42.4 | 30.7 | 20.1 | 67.8 | 79.9 | 10.2 |
| 189 | 2.4 | L* | 74 | 15.0 | 6.0 | 54.3 | 39.3 | 23.3 | 57.0 | 77.1 | 9.6 |
| 190 | 6.4 | L* | 78 | 17.4 | 8.1 | 52.3 | 40.7 | 26.1 | 56.0 | 81.1 | 12.7 |
| 191 | 7.4 | L | 42 | 21.5 | 9.2 | 42.8 | 33.1 | 21.8 | 65.1 | 81.1 | 11.9 |
| 195 | 19.10 | L | 187 | 22.8 | 14.4 | 38.0 | 25.1 | 17.9 | 71.6 | 92.0 | 12.1 |
| 196 | 20.10 | L | 188 | 20.0 | 12.1 | 41.2 | 28.2 | 20.0 | 68.8 | 95.0 | 12.0 |
| 198 | 6.12 | L | 39 | 15.9 | 9.5 | 51.1 | 36.0 | 23.0 | 64.8 | 87.4 | 11.1 |
| 199 | 7.12 | L* | 233 | 13.7 | 9.5 | 57.1 | 39.9 | 24.5 | 63.0 | 88.4 | 10.9 |
| 200 | 8.12 | L* | 234 | 13.0 | 11.8 | 58.5 | 40.4 | 24.4 | 59.8 | 88.7 | 11.2 |
| 201 | 9.12 | L | 42 | 14.3 | 9.7 | 52.3 | 37.8 | 19.6 | 69.2 | 91.3 | 11.1 |
| 202 | 10.2.77 | L* | 58 | 14.2 | 9.9 | 49.8 | 36.9 | 26.9 | 59.5 | 95.3 | 11.1 |
| 203 | 11.2 | L* | 59 | 13.8 | 10.1 | 50.5 | 37.3 | 24.1 | 61.5 | 91.8 | 11.1 |
| 204 | 16.3 | L* | 100 | 14.9 | 7.2 | 54.6 | 40.2 | 27.8 | 56.7 | 68.7 | 9.7 |
| 205 | 17.3 | L | 38 | 19.0 | 9.3 | 40.1 | 32.0 | 22.1 | 65.0 | 82.6 | 11.2 |
| 206 | 21.3 | L | 41 | 18.2 | 9.3 | 43.6 | 32.0 | 23.7 | 66.0 | 85.5 | 10.6 |
| 207 | 22.3 | L* | 103 | 12.1 | 7.8 | 58.3 | 44.9 | 28.8 | 53.6 | 70.6 | 9.8 |